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An Appraisal of Entomology and Entomologists

Presidential Address, Sixtieth Annual Meeting, American Association of Economic Entomologists

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Many of us can remember the time, and it was not too long ago, when meetings of entomologists attracted little or no attention. We can also recall how we wondered what approach we should use as individuals in speaking to others about our profession or avocation. Lack of public interest and uncertainty as to public attitude has had an effect, more important than we have realized, on the development of the science of entomology. As we think of our science today it is rather hard to appreciate why there was such indifference. As early as 1860 the lawmakers of our country recognized the importance of entomology by indicating the need for developing information on how to control insects. They even went so far as the establishment of special commissions to determine ways of controlling grasshoppers thus providing aid to farmers that would enable them to maintain their homes and farms in the newly developed agricultural areas of the Great Plains.

As we look back, this early recognition of the significant place that insects have in agriculture is not surprising to entomologists. Many of the annual addresses of presidents of our Association have pointed out the imporatnce of insects and the losses they cause. Entomologists generally have long known that insects as a class compete more directly with man than does any other group of animals. There is hardly a place on the earth inhabited by man where he is not annoyed, or his labors are not affected, by insects. Insects have had a very profound effect on the development of civilization. In the light of current knowledge it is not hard to point out instances where insects have had a far reaching influence on the history of nations and upon affairs of the world.

Had the early Romans recognized the disease-carrying habits of mosquitoes and devoted a small part of their effort to control them, the map of Europe might have quite a different appearance today. What fleas meant to Europe and Eurasia, especially during the time of the "black death," is now easily understood. Had the relation of mosquitoes to yellow fever and malaria been recognized a few years earlier than it was, the present short cut between the Atlantic and Pacific Oceans might be in a different place and under different control. What would this have meant to the Western Hemisphere is a matter of conjecture. Had the Texas fever tick not been brought under control, the agriculture of our Southern States would still lack the benefits of cattle and dairying. Had the Mediteranean fruit fly remained in Florida, the citrus industry of the South and the fruit cultures of other regions would have been so curtailed that certain fruits would still be used as dessert rather than as the breakfast "eye opener."

Illustrations such as these could be multiplied, and perhaps even better examples could be cited. It is not my purpose to point out the importance of insects. That we accept. We may, however well ask ourselves why it has taken so many years for entomology to get the recognition it has today. There is no doubt that the science is more generally appreciated now than it was even 10 years ago. It contributes more to the happiness, comfort, and economy of the world than it has at any time in the past. As entomologists we glory in this—perhaps far more than we should, as the intoxication of recognition may be affecting our judgment. In our enthusiasm it may be

well for us to look backward. If we do this we will find that entomologists are partly responsible for the delay in appreciation and recognition of our science.

APPRECIATION OF THE IMPORTANCE OF ENTOMOLOGY—STILL INADEQUATE.—For a science that received early recognition in the field of agriculture, through the establishment of official administrative units supported by appropriations, entomology has done far less than it should to help the farmer profit as he should if he used the information entomologists could supply. The number of trained specialists employed to advise farmers on matters pertaining to insects is considerably less than the number that deal with activities far less complex than those required to control insects.

In January 1948 there were 51 subject-matter extension specialists for entomology, 71 for home management, 70 for clothing, 108 for agricultural economics, 141 for agricultural engineering, 125 for dairying and 93 for poultry. Of the 32 categories of subject-matter extension specialists, 17 had a greater number of employees than did entomology. Why are there so few extention specialists in entomology? The annual losses insects cause to agriculture, through preventing full production and protection of agricultural commodities, is conservatively estimated as amounting to four billion dollars. Entomologists have developed safe and effective ways by which much of this loss could be prevented.

ENTOMOLOGISTS HAVE NOT TAKEN THE LEAD.—More than 20 years ago entomologists expressed the opinion—and supported it with reasonably satisfactory data—that the cotton boll weevil reduced the potential yield of cotton by 14 per cent each season in the states where this pest is well established. Their general estimate was accepted and well confirmed somewhat later by crop-reporting specialists. Significant as these conclusions were, and despite the fact that means were available for reducing the tribute paid to an introduced pest, little was done about it. Entomologists spent considerable effort to point out that more research would enable them to improve the remedies they had developed. They did too little to demonstrate that their use would prevent waste of energy, cost of seed and fertilizer and reduce the uncertainty of a profitable crop that confronted each farmer who planted cotton.

There is no doubt that more research should be done. But why did we do so little to see that available information was utilized to combat the pest? The demand for full production of essential food, feed, and fiber created by World War II did much to focus attention on the benefit that would accrue through the control of the boll weevil. This demand, however, came largely from the cotton industry. Entomologists willingly contributed information and did much to expand the effort. Many, however, are still loath to acclaim, or even acknowledge, the contribution their work made to enable our farmers to meet essential production goals. The current factual information on the occurrence and status of cotton insect pests obtained by field observations and its use to guide the distribution of insecticides to places where they were needed to do the greatest good did much to make production goals possible. Without these operations the results would have been different.

Since the beginning of the agricultural development in some 24 Midwest and Western States, farmers in that area have prospered or failed depending in no small way on the abundance of grasshoppers. The hordes of these pests have been accepted like weather. Less than 20 years ago many farmers demanded that something more than giving advice should be done to help them protect their right to maintain themselves on land they worked to develop. With some reluctance entomologists helped to develop a cooperative program by which this could be done. Fortunately that was before the world placed such heavy demands on the farmers of our country for all-out production of essential crops. Good weather and the determination to produce were not the only factors that made it possible to meet production goals. Weather is not the only factor that prevented major outbreaks of grasshoppers and Mormon crickets in recent years. Have entomologists been too busy with details to point with a pride they may justly have in the contribution they made to the welfare of the nation and the world? And if so, have they forgotten the genesis of the ideas that led to the development of the cooperative grasshopper control program?

Economists know, perhaps better than entomologists, what the codling moth meant to the deciduous fruit-growing areas of the Pacific Northwest. These areas were especially favorable to a pest which, when not controlled, made fruit production unprofitable. The procedures devised by the entomologist for control, however, created a problem of marketing which for a time was almost as destructive as the pest. There is no point in producing worm-free fruit unless it can be sent to market for the consumers. The part entomologists played in the coordinated, cooperative effort with scientists in other fields, including those responsible for health safeguards, did much for the economy of these agricultural areas, and provided clean fruit for a hungry world. Did our science receive the recognition it deserved? The next chapter in codling moth control may, if entomologists are wise, bring more to their credit.

Entomologists have long known that insects take a heavy toll from the grain supply of the Nation and the world. But even the entomologist has failed to fully appreciate the magnitude of the loss. Perhaps this is the reason why entomologists have not emphasized that part of this loss could be prevented. The recent unprecedented demand and need for food have prompted urgent requests for information on how to protect cereal grains so that they can be used for the purpose for which they were produced. Entomologists should take the lead and outline procedures for using their know-how to assure that this is done, even though better ways may later be devised. To be told that as much as 60 per cent of the grain grown and transported to areas where people need it is not suitable for human food is distressing. To hesitate to endeavor to correct this situation, even in part, is folly.

What entomology contributed to the outcome of the last World War, and to the health and comfort of the people throughout the world, is now rather generally recognized. It is a bright chapter in the history of our science. We as entomologists have long believed that such attainments were possible. Now that they have been proved, are we, or others, receiving the recognition for accomplishments based on knowledge of the habits, development, occurrence, and means for the control of insects? Whatever the answer, we must remember that it was the result of cooperative effort and that entomologists responded to a call. When the insecticidal value of DDT was discovered and developed it was unknown to the chemical industry, and its manufacture required materials that were high on the priority list. The part industry and those associated with it contributed to control of disease-carrying insects is second in importance to the basic discoveries. It took the two to make the accomplishments possible.

The foregoing examples of what entomology has contributed to human welfare could be multiplied many times. Many of you might select others which are even more significan . My purpose in listing them has not been to record our attainments or to provide comfort or satisfaction for entomologists. I have something entirely different in mind. It is to illustrate how we as entomologists have been slow and even failed to put our knowledge to work. I am continually impressed with the thought that we do not take the lead in initiating programs to alleviate the losses and annoyances caused by insects or in conserving or utilizing beneficial insects. Other scientists—and some which have less to contribute—do much more to see that the knowledge they develop is promptly applied. In many cases we have waited until others have concluded that insects should be controlled or used and sought our advice. That we have been ready and willing has been to our credit. Is that enough? I don't think so.

ENTOMOLOGISTS HAVE SPECIALIZED IN SPECIALIZATION.—If the foregoing comments are essentially correct, and I am convinced they are, it would seem well to inquire into the reasons for this attitude. That there is no simple answer is agreed, and it is doubtful whether there can be agreement on the most important factors, Much will depend on what we consider entomology to be.

The class Insecta—and the near relatives which the public and those who make our dictionaries call insects—includes more species that have a close or direct relation to man than does any other class of organisms. This fact adds to the complexity of the problem. As entomologists we have perhaps overemphasized this complexity. We have said there are so many kinds of insects that only a specialist

can distinguish the various kinds. We have gone so far as to indicate that being an entomologist is not enough. It has been said that identification requires a taxonomic entomologist and more than that—one who is a specialist in a limited group. Far be it from me to say this is not largely true. That it has been overemphasized, however, is most certain.

Field technicians have done excellent taxonomic work by accurately identifying the grub of the Japanese beetle, thanks to more highly refined, painstaking work of Boving who discovered and pointed out the characters that make such identification possible. Similarly, field workers separate with accuracy two species of blow-flies which are so similar in appearance that they were grouped under one name until Cushing and Patton discovered how they could be distinguished. Specialization in the classification and identification of insects is essential. To think that one has to be a taxonomic specialist before he can name insects and thus perform taxonomic work in entomology is a mistake. Biological and control work with insects requires taxonomy, and where it is well done the operator is an applied taxonomist. Should there be such a gap between the taxonomic specialist and other groups of entomologists?

The tendency—and even more than that—to separate the science of entomology into various fields of endeavor has led to the development within the science of lines of cleavage which are neither justified or desirable. It was not long ago that candidates for employment in entomology were divided into groups based on the type of crop the insects affected. This grouping was recognized by the Federal Civil Service, and colleges and universities arranged their courses accordingly. If the problem had to do with the cotton bollworm, the candidate came from a different background from the one selected to work on a problem created by the tomato fruitworm, even though the insect is the common, cosmopolitan *Heliothis armigera*. It is gratifying that this type of specialization in entomology is passing. There is still too much of it. We should recognize that it is entomology we are concerned with, and not segments thereof, in our training and employment practices. We should develop entomologists, be sure they know what the science is and how it is related to and dependent on other fields of knowledge. The sooner this is done the better qualified will be the personnel which is needed to assure that entomology contributes what it should to the welfare of the world. I do not mean that we should not recognize fields of interest and aptitudes. This is necessary. Overspecialization, however, results all too often in loss of perspective. There are many cases where specialized knowledge is needed. Often, however, this is a clear indication that coordinated, cooperative effort is also necessary to develop information required to get an answer to any problem. Such coordinated effort usually is needed before knowledge can be put to practical use.

The importance entomologists have given to the need for specialization has had a very significant influence on the development of the science of entomology. We have carried our ideas and hobbies on specialization too far. Contributions made by entomologists during the last World War would seem to clearly demonstrate that knowledge of entomology rather than specialization in a field such as how insects affect man or one of his crops, pays the greatest dividends. Latta knew little about lice when he developed, in markedly short order, a new means to kill them on clothing. It was his knowledge of insects and how they respond to fumigants that made this possible. A specialist in lice and insects that attack man could not have produced the answer in twice the time.

CONTROLS FOR INSECTS MUST BE PRACTICAL AND SAFE.—The tendency of entomologists to specialize within their own science has influenced their attitude toward other problems. It has, I believe, contributed in no small way to the attitude of circumscribing their interests and even to the all too frequent expression, "The job of the entomologist is to determine what will kill harmful insects and to devise ways of using those that are beneficial." For an entomologist to have such a narrow vision of his place in the problems of the world is without firm justification. Important as insects are, they are only one of many factors which play an important part in the affairs of man and the world.

Entomologist's effort will matter naught if what he determines will kill the insect cannot be safely used. Ways of using

beneficial insects that interfere with other essential activities may have no more than academic interest. A procedure for preventing or removing infestations of insects from a cargo of wheat has no merit if it will render the wheat unsuitable for food or so interfere with delivery to the consumer that he starves before it reaches its destination.

Restive as we may be to the restrictions that practical usefulness is the "pay-off" of our research, entomologists in general have long realized that insects had better be endured than combatted by devices or means that are not practical and safe. We were the first to ask the questions—what will the use of insecticides do to beneficial insects; what will the insecticidal residue do to the productivity of the soil; will the material hurt the plant or animal; what does the residue on the finished product mean to those who consume it; what does the material or practice do to other forms of wildlife; can the operator apply the control measures without harming himself. Entomologists planned the early tests to see what amount of lead arsenate remained in the soil and what effect it had on the normal flora of the New England states, before recommending this chemical for general use for insect control. Entomologists initiated and participated in studies to determine the effect of paris green on fish and to find out whether it could be safely used to control mosquitoes. Entomologists sought the counsel and assistance of wildlife specialists before arsenite baits were widely used to control grasshoppers. Entomologists had an important part in developing the safeguards that should be followed when hydrocyanic acid gas is used to control pests on citrus. These more recent illustrations of the entomologists' concern about the effect control practices may have on things other than the pest are not new. As long ago as 1874, and earlier when paris green was being developed for use against the potato beetle, tests were made to appraise its effect on the plant productivity of the soil and even to see if the insecticide affected the flavor or interferred with the safe usefulness of the tuber for food.

The first questions the entomologist usually asks about a new insecticidal chemical are—does it injure plants and can it be safely used. Four years ago, when we met in this same hotel, entomologists recommended and urged that more be learned about DDT before it was used extensively to combat all kinds of insect pests. History demonstrates that the entomologist has recognized the importance of determining whether chemicals can be safely used to control insects and that he has worked with others to provide the information needed. It is the exception when the entomologist has placed safety of use on the same level as how well and at what dosage the insect is killed. This is the sound attitude. Impatience is no excuse for changing it.

BALANCED COOPERATION NEEDED.—The tendency of entomologists to specialize within their own science has influenced the approach they have often followed to cooperate with specialists in other fields. They have often sought cooperation by direct contact. Fine as this is, it has meant that the cooperators have had the task of supporting entomological problems. It has also led to the neglect of other factors of equal importance. Farm management, land planning, marketing procedures and outlets, consumer preference, the relation to industry and the contribution industry must make by providing devices and materials have often been neglected. The scope of interest and concern has not been broad enough to assure that full benefits will accrue or that shortcomings will be detected. It may be claimed that this is not entomology, and if a restricted definition is used, this may be correct. It does, however, affect entomology, and such an answer is not satisfactory nor in keeping with what entomologists have done in appraising the usefulness of chemicals. Even though it may be outside the technical definition of the term, I maintain that where the primary problem has to do with insects the problem is basically entomological. The field of interest and concern of the entomologist should be broad enough to include those things which directly and indirectly have a bearing on the eradication, suppression and control of noxious insects and on the conservation and utilization of those that are beneficial. If such a concept is too broad, then so is the first objective of our Association which is "to promote the study and to advance the science of entomology."

Specialization within the science of

entomology is necessary. The field is so broad that no one can be well versed in more than a small part. But specialization must not be used as an excuse for isolation. It is a reason for something quite different —cooperation. If we look into history, we cannot be too proud of our record as cooperators. The competitive spirit of entomologists has always been well marked. The first to describe an insect, the first to discover a significant fact about how and where an insect behaves or lives, the first to demonstrate that material is a good insecticide, the first to devise a good control device or measure—these are expressions familiar to all. It is gratifying indeed that they are heard less frequently today. I do not mean that competition is no longer with us, or that the competitive spirit should be abandoned. We entomologists are still fully aware that initiative and competition are dominating principles of our Nation. We have, however, learned that there is something better than to be first—and that is to be sure we are right. With this we have become better cooperators—but we still have a long way to go before we "promote the study and advance the science of entomology" as we should. We must work closer with each other and much closer with workers in other fields of endeavor that have a bearing on the advancement of the science of entomology.

SPECIALIZATION HAS AFFECTED ENTOMOLOGISTS' RELATIONS WITH EACH OTHER —In this appraisal or analyses of entomology and entomologists I have directed attention largely to circumstances that have had a bearing on the economic development of our science and to factors that have contributed to retarding its advancement. Many things have been omitted, and perhaps some have had greater influence than those mentioned. If I would add another, it would be the reticence to claim membership in our profession. This has had a part, but perhaps the part is only a segment of the over-all lack of confidence and pride that would be ours if we saw entomology as a whole rather than only a section of the field. Our interest in and desire to foster specialization have contributed to this viewpoint. The same interests and desires have influenced the types of organizations we have built for exchanging ideas and getting acquainted with each other.

Specialized and local interests have resulted in the development of several organizations having avowed objectives aimed to foster and improve the science of entomology. Practically, however, they all including our Association, fail really to attain the broad objectives. Entomologists have no comprehensive organization. There is no agency that really represents the science of entomology. If there were such an organization, we might by such unison have greater confidence in our science and do more effectively the things we aspire to do. The strength of union has long been a cardinal principle of our country, and several sciences have found that solidarity of purpose can be best attained by following the example of the Nation. The idea merits careful study and scientific appraisal. This is especially important now that entomology has finally received recognition and there is need for the services of entomologists in the fields of public health, conservation, land management and industry in addition to agriculture—the field which first recognized its value.

The establishment of a section of our Association to consider matters pertaining to medical entomology is an important step and indicates how specialized lines of interest can be fitted into and made a part of the whole. It is gratifying that this increasingly important segment of the science of entomology has rounded out our scope of interest. Other fields of interest can well be added so there will be full opportunity to consider special interests within the broader framework of the science of entomology. This practice should be encouraged and done in a way that will be of mutual benefit to all those interested in and concerned with entomology. The science of entomology is now strong enough to build an organization that will support the tools and services necessary for strength and unity. There are many things that need to be done before we can have a strong, united front. Perhaps the most important one for us is to acknowledge a weakness of the past and recognize that no matter how important specialization is it inherently fails to accept that development in narrow lines of endeavor depend on progress of associated segments of the whole. No firm foundation for unity can be built on a belief that lines of specialization inspire

confidence in a brotherhood designed "to promote the study and to advance the science of entomology."

We entomologists should broaden our interests. We should take the lead in demonstrating and devising ways of using our knowledge of insects so the world will be benefited and not injured by them. We should accept more fully that our place in world affairs can best be filled if we see the problem as a whole— not as an entomological segment. If we do this, we will work closer together and with others who must help us "advance the science of entomology." We will accept the principle that strength comes with union and cooperation. We will still accept and protect specialization, but we will recognize its limitations. We will thus develop even greater pride in our science. We, the members of the two foremost entomological organizations in the world, can do much to bring this about. As an individual and as a member of both organizations, I desire to contribute my bit to attain these objectives.

New Insecticides for Plum Curculio Control—Second Report

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Cage tests with certain new insecticides that showed the most promise in 1947 (Snapp 1948) were continued at Fort Valley, Ga., in 1948 to obtain further information on the effect of these materials on plum curculio, *Conotrachelus nenuphar* (Hbst.), and on peach fruit and foliage, in comparison with that of standard lead arsenate sprays. Two pyrenones and two benzene hexachlorides with high gamma-isomer content were added to these tests. Benzene hexachloride, which appeared to be a promising plum curculio insecticide in 1946 (Snapp 1947), parathion, and toxaphene were also tested in replicated large-plot orchard experiments and, in addition to other materials, in replicated single-tree orchard experiments. Benzene hexachloride, parathion, and chlordan were tested against larvae in peach drops, and parathion against larvae in the soil.

MATERIALS.—Most of the materials used in these tests were commercial products. The proportions of active ingredients reported to be in them are indicated in the tables and discussion that follow.

Parathion, hexaethyl tetraphosphate, and tetraethyl pyrophosphate are extremely poisonous to man and must be handled with great care.

A mixture of zinc sulfate, 4 pounds,[2] and hydrated lime, 8 pounds, was used as a safener for lead arsenate in each application, and wettable sulfur, 6 pounds, was used for disease control in all applications 2 weeks after shuck-off and 4 weeks before harvest in the orchard experiments and in some of the cage tests.

CAGE TESTS.—Six series of cage tests were conducted from March to July. In four of the series the materials were applied to peach trees with a power sprayer (10 hp.-engine and No. 2 discs in a 3-nozzel spray broom) at a pressure of 300 to 375 pounds per square inch. In two of the series the materials were applied to peach trees with a double-acting hand spray pump at a pressure of 180 to 200 pounds. As soon as the spray had dried, wire-screen cages, each containing usually 25 plum curculios, were then placed over treated branches bearing fruit and foliage. Each cage had a cloth sleeve, which was tied at one end to a limb to hold it in place (Fig. 1). For three series of tests, which were begun during March and April, overwintered curculios, either taken from hibernation cages or jarred from trees in the orchard, were used. For the other tests, which were begun in June and July, first-generation curculios were used. All curculios were maintained in the insectary on untreated peach fruit and foliage between the time of collection or emergence and use in the tests. The full details of these tests will not be given, but the results are summarized in the following paragraphs.

Several of the insecticides gave better results against hibernating curculios than against those that developed during the season. First-generation adults reared dur-

[1] Julius P. Hollon assisted in all experiments reported in this paper.

[2] In this paper all quantities of insecticides are for 100 gallons of spray.

FIG. 1.—Cages used for cage tests to determine the effect of insecticides on plum curculio adults.

ing the current season seem to be stronger and more resistant to insecticides. Overwintered adults available for cage tests are often weak and easily killed.

Parathion was very effective against both overwintered and first-generation adult plum curculios. When used at the rate of 2 pounds of 25-per cent wettable powder, it killed all the adults within 3 to 4 days after the spraying. At 1 pound it killed all the adults within 3 to 6 days. The half-pound rate was not quite enough for best results against adults.

Benzene hexachloride, chlordan, and toxaphene showed promise in these tests, but often were little if any more effective than lead arsenate. When compared on the basis of approximately equal strengths of the gamma isomer in the diluted spray, the wettable powder prepared from technical benzene hexachloride was much more effective than the wettable powder or emulsion prepared from benzene hexachloride having a high gamma content or an emulsion prepared from technical benzene hexachloride.

Hexaethyl tetraphosphate and tetraethyl pyrophosphate at the rate of 1 to 800 gave good immediate kill of adults. Previous work, however, has shown that these materials have no lasting quality.

The pyrenones had no effect on plum curculio adults.

Residual Effect of Parathion.—Other tests were made in which peach trees were completely caged to determine the residual value of parathion for the control of new first-generation adults. These tree were sprayed with parathion at the rate of 1 pound on May 27 just before the insects were caged. Twenty-five new first-generation adults that emerged from the soil on May 26 and 27 and had done no feeding were then introduced into one cage on May 27, immediately after spraying, and the same number was introduced into other cages over sprayed trees 1, 2, and 3 weeks after spraying. When the tests were begun, 25 new first-generation adults were also placed in a cage over an unsprayed peach tree as a check. The trees were jarred at intervals to catch the live curculios. The results indicated that the spray deposits retained a little toxicity throughout a 3 weeks' period, although much of it had disappeared at the end of 2 weeks.

Additional data on the residual value of parathion for the control of plum curculios were obtained 2 to 30 days after the trees were sprayed by caging the insects on portions of peach trees at intervals after treatment. The beetles used in these tests were first-generation curculios that emerged between May 19 and June 10, and were maintained in the insectary on untreated peach fruit and foliage until the tests were begun. The results of these tests are given in table 1.

The results of these cage tests with parathion were in line with those mentioned earlier. At 1 pound of 25 per cent wettable powder little toxicity was left after 3 days in one case and after 7 days in another. At 2 pounds there was little evi-

Table 1.—Residual effect of parathion on first-generation adults of the plum curculio.

Parathion (Pounds of 25 Per Cent Wettable Powder per 100 Gallons)	Days from Application of Spray to to Caging of Curculios	Per Cent Mortality After Days Indicated				
		2	2 to 5	6 to 7	8 to 14	15 to 21
Sprays Applied on June 7[1]						
1	3	—	20	20	20	20
2	3	—	100			
	7	—	100			
	10	—	92	100		
	17	—	48		100	
None (wettable sulfur applied)[2]		—	4	8	20	20
Sprays Applied on July 19						
1	2	—	100			
	7	0	—	28	28	76
2	2	—	100			
	7	64	—	96	100	
	22	—	0	12		
None[3]		0	0	0	12	20

[1] Wettable sulfur, 6 lbs., added for disease control.
[2] Curculios confined June 7.
[3] Curculios confined July 21.

dence of toxicity after 22 days, and much of it had been lost by the seventeenth day.

ORCHARD EXPERIMENTS.—*Large-Plot Replicates.*—Benzene hexachloride, toxaphene, and parathion were compared with lead arsenate in experiments conducted under commercial peach orchard conditions. There were five replications of each treatment in a randomized set-up of plots, each of which contained 36 trees. When the fruit was harvested, all peaches were cut open to determine the percentage infested with the plum curculio. The results are given in table 2.

Table 2.—Results of orchard experiments with benzene hexachloride, toxaphene, parathion, and lead arsenate on large plots for control of the plum curculio on peaches.

TREATMENT[1] (Pounds per 100 Gallons)	TOTAL NUMBER OF DROPS FROM 40 RECORD TREES	PER CENT OF INFESTED DROPS (April 16–29)	PER CENT OF INFECTED FRUIT AT HARVEST
Benzene hexachloride wettable powder (6% gamma), 4	107	6.5	3.4
Toxaphene (26.3% wettable powder), 4	890	67.4	6.0
Parathion (25% wettable powder), 1	106	24.5	8.4
Lead arsenate, 2	1,379	81.1	10.4

[1] Lead arsenate used in 3-application schedule—petal fall, shuck-off, and 4 weeks before harvest. All other materials used in 4-application schedule—petal fall, shuck-off, 2 weeks after shuck-off, and 4 weeks before harvest.

The most striking differences in the data presented in table 2 are in the total numbers of peaches that fell from the trees receiving the several treatments. Statistical analysis shows that there are significant differences between the number of drops from the trees treated with benzene hexachloride and parathion and the number from the trees treated with toxaphene and lead arsenate, and between all three organic materials and lead arsenate. Benzene hexachloride and parathion are effective for the control of the plum curculio when the results are measured by the infestation in peach drops.

A statistical analysis of the data obtained by examining the fruit at harvest shows no significant differences in the results from the materials used in these experiments, except possibly between benzene hexachloride and lead arsenate (at 5-per cent level).

The peach orchard adjoining the block of trees used for the orchard experiments on large-plot replicates was fogged with tetraethyl pyrophosphate from an airplane about 2 weeks before harvest. Both foliage and fruit were injured. As the same type of injury was observed in some of the experimental plots, it is possible that the drift from the fog may have interfered to some extent with the results of these experiments.

Single-Tree Replicates.—To determine whether replicated single-tree plots would give results comparable to those obtained on replicated large plots for the control of the plum curculio, and to be able to test more materials for the control of that insect than is possible in large-plot experiments, orchard experiments on replicated single-tree plots were conducted in 1948 in addition to the large-plot experiments. Each of nine treatments, involving seven insecticides and a check, were replicated nine times in a randomized set-up of single-tree plots. When the fruit was harvested, all peaches were cut open to determine the percentage infested with the plum curculio. The insecticides used and the results obtained were as shown in table 3.

As in the 36-tree plots, the single-tree-plot experiments placed benzene hexachloride first, although in neither case did the difference between the benzene hexachloride and the lead arsenate treatments quite reach significance.

Persistence of Parathion Residues.—To determine the persistency of parathion deposits and of the residues at harvest

Table 3.—Results from replicated single-tree plots.

TREATMENT[1] (Quantities Per 100 Gallons)	PER CENT OF INFESTED FRUIT
Benzene hexachloride wettable powder (6% gamma), 4 lb.	7.9
Chlordan (47.2% wettable powder), 2 lb.	25.2
Toxaphene (26.3% wettable powder), 4 lb.	21.2
Hexaethyl tetraphosphate, 100%, 1 pt.	29.3
Parathion (25% wettable powder):	
0.5 pound	23.9
1	34.9
2	27.3
Tetraethyl pyrophosphate, 1 pt.	19.8
Lead arsenate, 2 lb.	19.9
Check (untreated)	35.1

[1] Lead arsenate used in 3-application schedule—petal fall, shuck-off, and 4 weeks before harvest. All other materials used in 4-application schedule—petal fall, shuck-off, 2 weeks after shuck-off, and 4 weeks before harvest.

Table 4.—Analyses for residues of parathion on sample peaches taken from experimental plots before and at harvest. Fort Valley, Ga., 1948.

Spray Dates	Sampling Dates	Parathion 25% Wettable Powder (Pounds per 100 Gallons)	Parathion Residues (p.p.m. on Total Weight Basis)			
			Four Weeks Before Harvest		At Harvest	
			Peel	Pulp	Peel	Pulp
March 22, April 5, 19, May 31	May 31, June 28	1	2.30	0.80	0.04	0.04
		0	0	0	.03	.02
March 24, April 8, 20, June 7	June 8, July 5	0.5	.65	.05	.07	.008
		1	1.33	.11	.06	.005
		2	3.18	.21	.11	.005
		0	.50	0	.02	0
July 19	July 30	1	—	—	.22[1]	—
		2	—	—	1.55	—
		0	—	—	0	—

[1] May be somewhat low for this sample owing to rotten condition upon arrival at laboratory.

time, a number of analyses were made of peaches from both series of field plots.[1] The samples were composite ones taken from all replicates. One set of samples was taken 28 days before harvest and another at picking time. These analyses were supplemented by others on peaches from trees given a special application 11 days before harvest. The results of these analyses are given in table 4.

The residual parathion on the peaches 4 weeks after spraying was negligible. The results of the chemical analysis, as well as those of the cage tests, indicate that an application closer to the ripening period than 4 weeks may be required for best results from parathion for plum curculio control. In both experiments the rainfall in the 4 weeks' period preceding harvest was less than a half-inch. In the cage tests the material proved to be so toxic to adults that excellent protection to peaches from the insect may be expected if there is sufficient residual material on the fruit throughout the swelling and ripening periods (4 weeks prior to harvest).

TREATMENT OF PEACH DROPS WITH BENZENE HEXACHLORIDE, CHLORDAN, AND PARATHION.—On April 15 peach drops that had been collected the previous day were sprayed with benzene hexachloride, chlordan, or parathion. For the spraying operation, the drops were spread out on the ground in a layer one peach deep to simulate orchard conditions. After treatment they were placed in racks in the laboratory for observations on larval emergence. An unsprayed lot was placed in another peach-drop rack to serve as a check. In each case the drops were placed only one layer deep in the racks to avoid, any fumigating effect from the treatments and to prevent molding of the drops.

Plum curculio larvae began to emerge from the drops on April 16, one day after the experiment was started, these were removed and counted daily thereafter until May 12, after which there was no further larval emergence from the untreated drops.

The larvae that emerged from the treated and untreated drops were placed in separate pupation boxes for observations on the effect of the materials on the development of adults. Emergence of adults began on May 23 and continued until June 26. The results of these experiments are given in table 5.

Benzene hexachloride and parathion applied on peach drops prevented many plum curculio larvae from maturing, but chlordan was not so effective for that purpose. It also appears that parathion affected the larvae that managed to emerge from the treated drops. The adults which developed from the larvae that emerged

[1] All parathion-residue analyses were made by the Analytical Research Laboratory, American Cyanamid Company, Stamford, Conn.

Table 5.—Results of tests with peach drops (1½ peck) treated with organic materials (Drops collected on April 14 and treated on April 15.)

Treatment (Pounds per 100 Gallons)	Larvae Emerged from Drops April 16 to May 12	Per Cent Becoming Adult
Benzene hexachloride (6% gamma):		
4	727	77
8	445	66
12	391	63
Chlordan (47.2% wettable powder), 4	1,101	59
Parathion (25% wettable powder), 2	408	15
Check (untreated)	813	69

from the parathion-treated drops were also affected by the treatment.

TREATMENT OF SOIL WITH PARATHION.—Parathion was also tested against larvae in the soil. Sixty-nine per cent of the larvae placed in untreated soil emerged as adults, whereas only 11 per cent emerged from soil treated with parathion (6 pounds of 25 per cent wettable powder applied at the rate of 1 gallon per 6 square yards of soil 5 to 10 days after the larvae had entered). About 20 per cent of the treated larvae reached the adult stage and managed to get to the surface but died there. Subsequent observations showed that there was little if any effect on the longevity of the adults that developed from larvae in soil sprayed with parathion.

EFFECT OF THE NEW INSECTICIDES ON PEACH FRUIT, FOLIAGE, AND TREES.—Moderate to heavy foliage injury and defoliation were recorded from hexaethyl tetraphosphate and tetraethyl pyrophosphate, both at the rate of 1 to 800, and the tetraethyl pyrophosphate at that rate injured 1.1 per cent of the harvested peaches. No injury to peach fruit, foliage, wood, or buds resulted from benzene hexachloride, 4 pounds of 50 per cent wettable powder (6 per cent gamma); chlordan, 2 pounds of 47.2 per cent wettable powder; toxaphene, 4 pounds of 26.3 per cent wettable powder; and parathion, 0.5, 1, and 2 pounds of 25 per cent wettable powder. Lead arsenate caused about the usual amount of injury.

The flavor of the ripe fresh peaches was not affected by benzene hexachloride, 4 pounds of 50 per cent wettable powder (6 per cent gamma), applied on March 22, April 5, April 19, and May 31, the last application being 4 weeks before harvest.

SUMMARY.—In cage tests carried on at Fort Valley, Ga., in 1948, sprays of parathion at rates of 1 to 2 pounds of 25 per cent wettable powder per 100 gallon of water killed 100 per cent of plum curculio, *Conotrachelus nenuphar* (Hbst.), adults within 3 to 6 days. This material caused some mortality of adults after it had been on the trees 3 weeks, although much of its toxicity had been lost by the end of 2 weeks. A wettable powder prepared from a technical grade of benzene hexachloride seemed more effective than wettable powders or emulsions prepared from benzene hexachloride having a high gamma-isomer content.

In orchard experiments benzene hexachloride and parathion were effective for the control of the plum curculio when the results were measured by the infestation in peach drops. There were, however, no differences between the results obtained at harvest with these two materials and those from toxaphene. Chemical analyses showed that the parathion was not applied close enough to the harvesting period for best results.

Benzene hexachloride and parathion applied on peach drops prevented many plum curculio larvae from maturing, but chlordan was not so effective. Parathion affected the larvae that managed to emerge from treated drops, and it also affected larvae in the soil.

Benzene hexachloride (6 per cent gamma) at 4 pounds per 100 gallons applied on March 22, April 5, April 19, and May 31, the last application being 4 weeks before harvest, did not affect the flavor of the ripe fresh peaches. Hexaethyl tetraphosphate and tetraethyl pyrophosphate, at the rate of 1 to 800, caused foliage injury and defoliation, and the pyrophosphate injured 1.1 per cent of the harvested peaches. No injury to peach fruit, foliage, wood, or buds resulted from sprays of benzene hexachloride, chlordan, toxaphene, or parathion. Lead arsenate caused about the usual amount of injury.

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Biology of the Plum Curculio in Maine

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The plum curculio, *Conotrachelus nenuphar* Herbst, is one of the major pests of deciduous fruits in the eastern half of North America, from the Gulf of Mexico to Southern Canada (Quaintance & Jenne 1912, Chapman 1938). The biology of the species has been the subject of intensive research, conducted largely in or near the area of maximum infestation, from Georgia to Massachusetts and from Connecticut to Illinois.

The study reported here is of special interest perhaps, because the observations were made at Highmoor Farm, Monmouth, Maine, located near the northeastern limit of distribution of the insect.

WINTER SURVIVAL.—To obtain the adult curculios, infested apples were placed in trays over bottomless ground boxes. Before the adults began to emerge from the soil, the trays were moved, and cages were placed over the ground boxes. The adults were collected daily as they emerged from the soil, and were placed in hibernation cages. Each hibernation cage consisted of a wooden box 8.5×12.5×5.75 inches, inside. The top and the bottom were closed by 18-mesh, galvanized wire screen. Hay and dry leaves were placed in each cage for the support and protection of the beetles, and apples were supplied for food. In the spring a wire screen trap was placed near the top of each cage, so that the active beetles could not easily drop back into the litter at the bottom of the cage, when the daily inspection was made.

In the late fall, the hibernation cages were placed on a bed of shavings and hay about 8 or 10 inches deep, and covered by a blanket of hay about 24 inches thick, held in place by birch branches. This whole artificial hibernaculum was located on sod beneath an apple tree. In the fall of 1939 and again in 1940 a wooden roof was placed over the hay, but was not used during the other winters.

In the early spring, soon after the snow left the ground, the hay cover was removed from the hibernation cages, and daily observations were started.

The data on winter survival are summarized in Table 1. It is interesting to notice that survival ranged from 0.4 per cent in the winter of 1940–41 to 30.7 per cent in the winter of 1941–42, with an average survival of 12.4 per cent over the 7-year period.

It seems evident that there is a complex of interrelated factors influencing survival. Three important factors are the nature of the hibernation quarters, temperature, and precipitation. It was thought that the hay cover would give the curculios optimum protection. Judging by the results, however, it seems doubtful if survival in the protected cages was higher, on the average, than might have occurred had the beetles been allowed to seek hibernation quarters for themselves.

In a survey of the influence of temperature upon survival, the closest correlation was found when the monthly mean minimum temperatures during December, January, and February were considered. Sub-average minimum temperatures during this period appeared to be associated with sub-average survival (Table 1). A glaring exception occurred during the winter of 1939–40. Perhaps the roof covering that was placed over the hibernaculum gave extra protection, and increased the percentage of survival that winter.

The greatest effect of precipitation seemed to occur during the period of January, February, and March. Precipitation evidently affected the beetles by modifying the moisture present, and also, in the form of snow, by modifying the protective cover. Whitcomb (1929) in Massachusetts stated, "in 1927–28, an unusually open winter, several cages of beetles with a 6-inch covering of leaves, some exposed and others protected by a roof, suffered 90 per cent to 100 per cent mortality." In Maine it was found that when sub-average precipitation occurred during January, February, and March, sub-average survival of the beetles occurred (Table 1). The greatest deficiency of precipitation occurred during the winter of 1940–41, and was accompanied by the lowest percentage of survival that occurred during the 7-year period. When the protective covering was removed in

[1] The author is indebted to Mr. Fred Kinney and Mr. Arnold Pitman, who did most of the field work in this study.

Table 1.—Winter survival of plum curculio, Monmouth, Maine.

Winter	Number of Adults		Percentage of Survival		Average Monthly[1] Mean Minimum Temperature (°F.)		Total Precipitation[1] (inches)	
	Placed in cages	Emerged in Spring			Dec.–Jan.–Feb.		Jan.–Feb.–March	
1936–37	3271	703	21.5	+ 9.1[d]	18.6	+4.4[d]	13.57	+3.42[d]
37–38	9280	661	7.1	− 5.3	12.6	−1.6	10.09	− .06
38–39	12090	274	2.3	−10.1	13.3	− .9	10.09	− .06
39–40	5270	1105	21.0	+ 8.6	13.5	− .7	10.53	+ .38
40–41	9950	41	.4	−12.0	14.1	− .1	7.12	−3.03
41–42	10902	3346	30.7	+18.3	14.8	+ .6	12.14	+1.99
42–43	2907	103	3.5	− 8.9	12.5	−1.7	7.53	−2.62
7-year average			12.4		14.2		10.15	

[1] Calculated from U. S. Weather Bureau records, Lewiston, Maine.
[d] Deviation from the 7-year average.

the early spring of 1941, the cages were observed to be dry. The exceptionally low survival probably was due to a considerable degree to actual lack of moisture. The roof, used for the second time, in 1940–41, though not entirely weather tight, may have intensified the dry condition of the hibernaculum, and therefore may have increased the winter mortality of the curculios.

Table 2 shows an average survival of 66.9 per cent during three winters at Fort Valley, Goergia (Snapp 1930). The monthly mean minimum temperatures during December, January, and February averaged 41.2° F. at Fort Valley, Georgia, compared with 14.2° F. at Lewiston, Maine. Whitcomb (1929) reported an average winter survival of 25 to 40 per cent in Massachusetts.

The plum curculio usually is a much less destructive pest in Maine than it is farther south. The difference probably is in part the result of the comparatively severe mortality suffered by the curculios during Maine winters.

EMERGENCE FROM HIBERNATION.—Data showing the emergence of the plum curculios from hibernation at Monmouth, Maine, are presented in table 3 and figure 1. The beginning of emergence (0.1%) varied from April 17 to May 11, and from 41 days to 20 days before petal fall of McIntosh apples. The completion of emergence (98%) varied from May 22 to July 12, and from 5 days before petal fall to 43 days after petal fall. The shortest period of emergence was 16 days and the longest was 69 days, with an average of 44 days.

As might be expected, there was considerable fluctuation from day to day in the number of curculios that emerged. Garman & Zappe (1929) found that temperature and rainfall are important factors influencing the emergence of curculios from field cages in Connecticut. During dry seasons they found rainfall to be

Table 2.—Winter survival of plum curculio in Bermuda grass, Fort Valley, Georgia.

Winter	Percentage of Survival[1]		Average Monthly[2] Mean Minimum Temperature (°F.)		Total Precipitation[2] (inches)	
			Dec.–Jan.–Feb.		Jan.–Feb.–March	
1922–23	73.8	+ 6.9[d]	42.93	+1.69[d]	5.58	+.26[d]
23–24	51.4	−15.5	39.96	−1.28	4.72	−.60
24–25	75.4	+ 8.5	40.83	− .41	5.66	+.34
3-year average	66.9		41.24		5.32	

[1] Data from Snapp 1930 (Tables 45, 47, and 48).
[2] Calculated from U. S. Weather Bureau records, Fort Valley, Georgia.
[d] Deviation from 3-year average.

especially important. In Maine, similar effects were observed. A number of times it was noted that rainfall during the emergence period was followed by a distinct increase in emergence. The effect was not consistent, however, and frequently variations in emergence were ob-

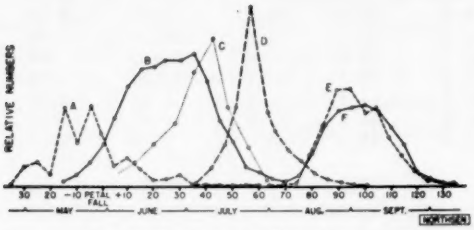

FIG. 1.—Seasonal cycles of the plum curculio at Monmouth, Maine. A. Adults emerging from hibernation. B. Adults of the first brood in the apple trees. C. Oviposition, as indicated by the number of eggs in apple fruits. D. Larvae leaving dropped apples. E. Emergence of second-brood adults from the soil. F. Adults of the second brood in the apple trees. The data are plotted on the petal-fall scale, and the average calendar dates are shown. Except for B. and F., the comparative vertical heights of the several sections are intended as suggestive only. The data represent: A. 7 years, 6244 adults; B. and F. 5 years, 12378 captures; C. 3 years, 2115 eggs; D. 5 years, 11959 larvae; E. 6 years, 34189 adults.

served that could not be explained readily as effects of either rainfall or air temperature. It seems probable that direct sunlight falling upon the hibernation place, raised the temperature considerably higher than the surrounding air temperature. On cloudy days the temperature within the hibernation quarters probably sometimes remained lower than the temperature of the general atmosphere. As an index to emergence, neither precipitation nor air temperature was consistent or accurate, regardless of whether the records were made at the time of emergence or during short periods preceding specified percentages of emergence (Table 4). High correlation was found between cumulative emergence and the cumulated daily mean temperature and rainfall for a period of approximately 30 days preceding any given percentage of emergence. Such records may be useful in predicting emergence, as shown by Lathrop & Dirks (1945) for *Rhagoletis pomonella.*

The awakening of the curculios from hibernation appears to be a somewhat gradual process. Probably the beetles remain sluggish for a while, and it is not unlikely that they may venture out on warm days in the early spring and return to protected places when the weather is unfavorable. Such behavior may account for the lapse of time between the emergence from hibernation of a large proportion of the curculios and their appearance in the apple trees.

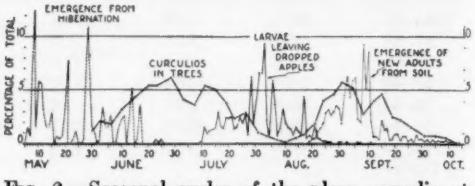

FIG. 2.—Seasonal cycles of the plum curculio at Monmouth, Maine, in 1939. Petal fall of McIntosh apples occurred on June 6 in 1939. The average date of petal fall is June 29.

ADULTS IN APPLE TREES.—To determine the numbers of curculio beetles in the trees, each year a number of neglected apple trees with a good crop of fruit, and well infested with curculios were selected and were "jarred" periodically. The curculios were counted and immediately replaced upon each tree.

As previously noted by other authors (Garman & Zappe 1929, Whitcomb 1929, Chapman 1938) the curculios begin to appear in the apple trees about the time of the "pink" blossom stage. Quaintance and Jenne (1912) and Snapp (1930) observed that beetles sometimes were found in peach trees at Fort Valley, Georgia, when the temperature was as low as 55° F., and "a mean temperature above 60° for several successive days will bring out the beetles en masse." The same relationship between temperature and the migration of the beetles to the apple trees appears to hold true in Maine. The average daily mean temperature during the 5 years of the study reached 60° 3 days before petal fall, just about the time of most rapid increase in the numbers of curculios found in the apple trees (Fig. 1). On the average, through the 5-year period, the numbers of adults in the trees increased rapidly during late May and early June until a broad, comparatively level peak was reached in mid-June, about 15 days after petal fall. The broad peak continued for a period of about 20 days, after which the average numbers of curculios jarred from the trees declined rapidly through most of the month of July. The lowest numbers occurred in early August, about 70 days

after petal fall, when most of the first brood adults had disappeared, and before many of the second brood had emerged.

The adults of the second brood appeared in the trees as the new beetles emerged from the soil (Fig. 1). On the average the second brood reached a peak in the trees early in September, about 100 days after petal fall, after which the numbers declined rapidly.

Maine. The samples were brought to the laboratory and carefully examined. Records were made of the number of apples bearing egg punctures, and the number of punctures in each sample. Each puncture was examined and the number of eggs present at each date was determined. The results of the study are illustrated in figure 1. During the three years of the study, oviposition began as early as May

Table 3.—Dates of emergence of plum curculio from hibernation at Monmouth, Maine.

YEAR	DATES[1] OF SPECIFIED PERCENTAGES OF EMERGENCE							DURATION OF PERIOD (DAYS)
	0.1%	10%	30%	50%	70%	90%	98%	
1937	May 11 −20	May 12 −18.3	May 14 −16.6	May 22 −13.2	May 17 − 8.4	May 25 − 5.4	May 26 − 5.0	16.0
1938	May 4 −26	May 22 − 7.4	May 26 − 3.5	June 5 + 6.3	June 12 +13.4	June 27 +28.5	July 12 +43.4	69.4
1939	May 6 −31	May 8 −28.4	May 12 −24.1	May 23 −13.2	May 31 − 5.8	June 13 + 7.2	June 17 +11.6	42.6
1940	April 25 −41	May 4 −31.6	May 18 −17.4	May 26 − 9.9	May 31 − 4.6	June 7 + 2.5	June 12 + 8.0	49.0
1941	April 27 −25	May 5 −16.4	May 10 −11.7	May 11 −10.2	May 27 + 5.7	June 12 +21.4	June 16 +25.6	50.6
1942	April 17 −34	April 19 −31.5	May 4 −16.6	May 12 − 8.3	May 15 − 5.2	May 19 − 1.4	May 22 + 2.1	36.1
Average	April 30 −29.5	May 7 −22.3	May 15 −15.0	May 21 − 8.1	May 29 − 0.8	June 7 + 8.8	June 13 +14.3	44.0

[1] The calendar dates are given and also the number of days before (−) or after (+) the date of petal fall of McIntosh apples.

The numbers of second brood adults in the trees averaged considerably less than those of the first brood (Table 5). Evidently many adults of the second brood were going into hibernation, even while emergence from the soil was in full progress. Thus the total numbers of second brood adults were not all in the trees at any one time. It is interesting to notice that the highest peak of adults occurred in the first brood in 1941 (Table 5), which followed the lowest winter survival (Table 1).

OVIPOSITION.—Data on oviposition were obtained in 1940, 1941, and 1942. Samples of from 200 to 400 apples were picked about once a week, beginning within a few days after the first curculio egg punctures were observed, and continuing until eggs were no longer present. The apples were picked at random from a large number of neglected trees scattered over a considerable area in Monmouth,

29 (1942) and as late as June 10 (1940), or from 6 days after petal fall (1940) to 12 days after petal fall (1942). The peak occurred from June 25 (1942) to July 11 (1940), or from 36 to 41 days after petal fall. Oviposition continued through a minimum of 55 and a maximum of 62 days.

The number of eggs per 100 apples at the peak of oviposition was 62 in 1940, 69 in 1941, and 31 in 1942. It seems significant that the average maximum temperature for 5 days preceding the peak of oviposition was 86.0° F. in 1940, 90.4° in 1941, and 75.6° in 1942.

Whitcomb (1933), found that under controlled conditions in the laboratory the average number of eggs deposited "increased in the approximate ratio of 1:5:9:12 with each increase of 10° from 55° to 85° F." The beginning of oviposition and the number of eggs present in the apples from time to time through the

oviposition period do not appear to be dependent entirely upon temperature, however. The rate of growth and the size of the young apples and perhaps the stage of development of the curculios probably are contributing factors determining the beginning of oviposition. The number of eggs deposited, of course increases as increasing numbers of curculios come into

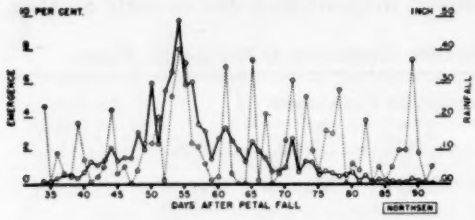

FIG. 3.—Daily emergence of plum curculio larvae (solid line) from dropped apples at Monmouth, Maine, in relation to daily rainfall (dotted line). The data represent the average for 5 years, including 11959 larvae. Notice that the emergence of large numbers of larvae in mid-period, and the decreasing numbers toward each end, obscures the quantitative effects of rainfall.

the trees then, after the peak of oviposition has passed, the number of eggs in the apples declines as the number of curculios in the trees decreases. The exact effect of temperature, therefore, is somewhat obscured. Nevertheless, a consideration of the oviposition records showed an evident relationship between temperature and the number of eggs present in the apples. The effect was most evident rather early in the egg-laying period, when the rate of oviposition was rapidly increasing. During this time an increase in the 5-day average temperature accelerated the rate of oviposition and a decrease in the 5-day average temperature retarded the rate of oviposition. The most impressive example of the influence of temperature upon oviposition occurred in 1942. In that year, the average maximum temperature was 75.6° for the 5-day period preceding June 10, on which date 31 eggs per 100 apples were present. The corresponding temperature preceding June 19 was 65.2° and the egg count per 100 apples dropped to 23. Had the temperature remained at 75° an egg count of 45 would have been expected.

LARVAE LEAVING FALLEN APPLES.—Before the larvae began to leave the fallen fruits, the length of time spent in feeding varied from about 27 days for the early larvae, during June, to about 14 days at the peak of larval occurrence, during July. To determine when the larvae left the fruits, heavily infested, dropped apples were collected about once a week, beginning when few, if any, of the larvae had left the apples, and continuing until larvae no longer were present in the drops. The apples were placed in wire mesh trays over cloth bottom boxes, and the larvae were collected daily from the boxes into which they fell. The study covered the five years, 1938 to 1942, inclusive.

Larvae began leaving the apples between June 30 and July 13, or between 34 and 41 days after petal fall. During any one season, the emergence varied greatly from day to day (Fig. 2), but over the five-year period, the average emergence

Table 4.—Emergence of plum curculio from hibernation at Monmouth, Maine. Average of daily temperatures[1] for 5 days preceding emergence of 10 per cent, 50 per cent, and 90 per cent.

1937	1938	1939	1940	1941	1942	6-YEAR AVERAGE	
			10 per cent emergence				
42.4	45.0	39.0	43.0	38.6	35.8	40.6	Minimum
53.4	54.9	51.1	52.3	48.5	44.3	50.8	Mean
64.4	64.8	63.2	61.6	58.4	52.8	60.9	Maximum
			50 per cent emergence				
41.2	51.0	44.2	49.4	47.0	38.8	45.3	Minimum
51.0	62.9	50.8	53.8	57.6	49.7	54.3	Mean
60.8	74.8	57.4	58.2	68.2	60.6	63.3	Maximum
			90 per cent emergence				
42.4	62.4	55.0	54.8	52.2	50.0	52.8	Minimum
57.1	72.3	67.1	66.3	61.1	57.1	63.5	Mean
68.0	82.2	79.2	77.8	70.0	64.2	73.6	Maximum

[1] Calculated from U. S. Weather Bureau Records for Lewiston, Maine.

increased rapidly (Fig. 1) until a sharp peak was reached during the last half of July, about 55 days after petal fall. Following the peak, the numbers of larvae leaving the drops declined until the end of the emergence period. The last larvae emerged between August 16 and September 11, or between 73 days and 102 days after petal fall. The length of the larval emergence period varied between 32 and 68 days.

The larvae emerged from the fallen apples during the period when the highest average temperatures usually occur in this section. Perhaps for this reason no very evident effect of temperature upon emergence was noted. A striking relationship between rainfall and larval emergence was evident, however, as shown in Figures 3 and 4. Rains during the emergence period frequently were followed by increased emergence of larvae.

Garman & Zappe (1929) and Chandler (1932) called attention to the sensitivity of the plum curculio to moisture conditions. The close relationship between rainfall and the emergence of larvae from the dropped fruits is illuminating and stimulates interest. Such data are not readily placed on a quantitative basis, however. The great variation in the numbers of larvae emerging at different times during the emergence period, *i.e.*, the small numbers leaving the fruits early in the period and late in the period, and the comparatively large numbers during midemergence, obscures the quantitative effects of factors such as temperature and rainfall.

EMERGENCE OF ADULTS FROM THE SOIL.—Larvae from fallen apples were collected in the cloth-bottom boxes and were placed in bottomless soil boxes. In addition fallen apples sometimes were gathered and placed on wire screen trays so that the emerging larvae could drop directly into bottomless soil boxes. Emergence cages were placed on the soilboxes in time to capture the emerging beetles. Daily observations and records of the beetles as they emerged from the soil were made during 1937 and 1939 to 1942 inclusive.

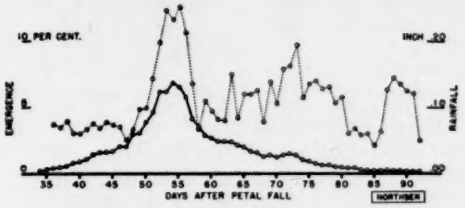

FIG. 4.—The data from Fig. 3, smoothed by means of a 5-day moving average, to show the more general pattern.

The record of the 6 years is summarized in figure 1. The earliest emergence occurred on July 20 (1941) and the latest date that emergence began was August 21 (1936). With respect to petal fall, the respective dates were 67 days (1938) and 83 days after petal fall (1936). The records for the individual years show considerable variation in the number of beetles that emerged from day to day (Fig. 2). The average emergence over the 6 years, though somewhat irregular approached the form of a normal distribution curve. The peak, when 50 per cent of the adults had emerged each year, occurred between the extremes of August 22 and September 8, or between 84 and 101 days after petal fall. The average date of the peak was August 31, or 94 days after petal fall. The length of the emergence period varied from 36 days in 1940 to 85 days in 1938.

During four years the percentages of adults that emerged from known numbers of larvae were determined and are shown in table 6.

Table 5.—Peak of occurrence of adult plum curculios at Monmouth, Maine.

	1938	1939	1940	1941	1942
1st Brood Peak					
Date	June 30	June 28	July 6	June 19	June 10
Days after petal fall	32	23	32	29	21
Number captured[1]	237	83	139	268	188
2nd Brood Peak					
Date	Aug. 20	Aug. 31	Sept. 18	Aug. 26	Aug. 17
Days after petal fall	83	87	106	97	89
Number captured[1]	99	77	171	130	46

[1] Number of beetles captured in 15 neglected apple trees in 1938, 1939, and 1940; 10 trees in 1941 and 1942.

Table 6.—Percentages of adult plum curculios which emerged from known numbers of larvae.

YEAR	NUMBER OF LARVAE	NUMBER OF ADULTS	PERCENTAGE OF ADULTS
1939	5807	2127	36.6
1940	1912	788	41.2
1941	2634	1330	50.5
1942	893	362	40.5
Average			42.2

Because the emergence of adults from the soil occurred so late in the season, it seemed possible that the emergence might be cut short by cold weather before all of the adults had emerged, and that larvae and pupae in the soil might survive the winter and emerge as adults during the following summer. In the summer of 1941, cages were placed again over the ground boxes from which the adults had emerged in 1940. Though the cages were kept under close observation through the summer, not a single curculio was observed in them in 1941.

Neiswander (1948) in Ohio observed marked correlation between rainfall and the emergence of plum curculios from the soil. In Maine there appeared to be no distinct correlation between rainfall and emergence. Perhaps during the years of the study, rainfall was sufficiently well distributed so that lack of moisture was seldom, if ever, a critical factor limiting the emergence of the beetles. Temperature appeared to show more effect than rainfall. In several instances temperatures of 80° or 85° F. for a few days were followed by increased emergence of adults from the soil. Even temperature, however, did not show any very obvious effects upon the numbers of beetles that emerged from day to day.

As the curculio beetles emerged from the soil they were placed in hibernation boxes with hay and leaves for support and protection and supplied with apples for food. In nature, these second brood beetles fed upon apples for some time before going into hibernation, and in Maine apple orchards late feeding by the beetles caused considerable, though minor, injury to the fruit. There was no evidence of oviposition by the second brood beetles.

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NOTICE

Beginning with Volume 43, February, 1950, the subscription price of the JOURNAL will be $8.00 per year to non-members.

INDEX VII of American Economic Entomology has recently been distributed to members of the Association. It is now available to non-members at $7.00 per copy. Orders should be addressed to E. N. Cory, College Park, Maryland.

Hibernation of the Plum Curculio in Virginia

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For many years recommendations for plum curculio control have usually included the burning of woodland and debris adjacent to peach orchards during the winter. Research workers in many states have stated that the adult curculios spend the winter under leaves and trash in woodland, fence rows, honeysuckle growth, pruning piles, along grassy ditch banks, etc., and that the burning over of such places during the winter months is a valuable supplementary control measure (Quaintance & Jenne 1912; Snapp 1928, 1930, Whitcomb 1932, Hutson 1933, Stearns *et al.* 1935, Woodside 1935, Graham 1938). Snapp (1930) made observations on the hibernating habits of the plum curculio in Georgia and found a small percentage of the beetles in the first 1-inch layer of soil but none in the second, third, and fourth 1-inch layers.

This paper presents data on the place of hibernation of plum curculio beetles and the value of early spring during as compared with winter burning of debris around the orchard.

Winter Burning Versus Early Spring Burning.—It was observed during the winter of 1936–37 that winter burning (January and February) was killing few if any plum curculio beetles and it was thought that early spring burning of woodlands adjacent to the orchard might be more effective. Two orchards at Crozet, Virginia, which had practiced winter burning for a number of years and which followed similar spray schedules were used in the tests. Orchard A had the higher beetle population and it was chosen to be burned in the early spring. The burning was done at the time the first beetles were jarred from the peach trees, or about the "pink stage" of bud development (late March). The woodland around orchard B was burned during the period of January to early February.

Table 1 shows that during 1935 and 1936 when the debris around the orchards was burned during the winter, orchard A had the higher beetle population but when spring burning was practiced in orchard A and winter burning in orchard B during the years 1937 to 1942 inclusive, the beetle population decreased in orchard A and increased in orchard B. There was approximately a 75 per cent decrease in the beetle population in the orchard practicing spring burning as compared with the orchard practicing winter burning.

Hibernation Studies, 1937–38.—Since spring burning of curculio hibernation quarters in 1937 indicated that a higher percentage of the beetles had been killed than with winter burning it was deemed advisible to find out where the beetles hibernated. In the fall of 1937 hibernation cages were placed over grass-covered ground and plum curculio adults liberated therein. Examination of the cages during the winter revealed no beetles under the dead grass on the ground surface. In the spring, however, slightly more than 50 per cent of the beetles liberated in the cages the previous fall emerged from the soil.

Hibernation Studies, 1946–47.—During the winter of 1946–47, cages which had a framework of wood and sides and top of 16-mesh hardware cloth were used in hibernation studies. The cages were 36 inches square and had a door to permit entrance. The cages were placed over desired hibernating quarters without disturbing the soil (Fig. 1).

Plum curculio adults which had been obtained from peach orchards by jarring trees late in the summer were confined in the cages. In late winter the surface of the ground in the cages was examined for beetles hibernating on the surface or under cover provided. Then, the soil was dug from the cages inch by inch. Each inch layer was screened through two screens. The first was of quaterter-inch-mesh hardware cloth and removed the large debris but permitted the curculio beetles to pass through, and the second was of 12-mesh hardware cloth which permitted only grains of dirt to pass through. The remaining soil was carefully examined and all beetles hibernating in each inch layer of soil recorded.

Three hibernating cages were used during the winter of 1946–47. Cage 1 was placed in dense honeysuckle growth near a stream. The soil was moist, covered

with dead leaves and other trash, and was of the red clay type. Cage 2 was located in woods on relatively high ground. The soil was very rocky and hard and was covered to a depth of one inch with dead leaves. Cage 3 was placed over loose soil with dead leaves and grass on the surface. The soil from cages one and two was screened and examined for hibernating plum curculio beetles in early March. data. The exact depth at which all of the beetles hibernated was not determined as extremely warm weather during the middle and latter days of February incited the beetles to activity and emergence began. An examination of the cages on January 15, 1948, however, showed no beetles on the surface. The soil was screened and thoroughly examined for curculio adults on February 26 and the data obtained are

Table 1.—A comparison of effectiveness of winter burning and early spring burning of debris adjoining peach orchards for plum curculio control.

Year	Number of Tree Jarrings	Orchard A			Orchard B		
		Trees	Beetles	Beetles per Tree	Trees	Beetles	Beetles per Tree
		Winter Burning			*Winter Burning*		
1935	1	8	23	2.88	10	7	0.70
1936	6	47	98	2.09	86	136	1.58
Total	7	55	122	2.22	96	143	1.49
		Spring Burning			*Winter Burning*		
1937	4	40	57	1.43	52	150	2.88
1938	3	25	18	0.72	33	57	1.73
1939	6	40	147	3.68	35	307	8.77
1940	6	36	27	0.75	35	137	3.91
1942	2	20	5	0.25	10	21	2.10
Total	21	161	254	1.58	165	672	4.07

Cage 3 was used for emergence studies and soil thermometers were used to record the daily maximum and minimum soil temperatures at depths of 3, 6, and 12 inches during March, April, and May.

Data presented in table 2 indicate that adults of the plum curculio hibernate in the soil. No live beetles were found on the surface although a number of dead beetles were found in the surface layer of leaves and trash. The winter mortality averaged 78.85 per cent. The average depth in the moist, red clay soil where the curculios were found was 2.52 inches, and in the hard, rocky soil 1.58 inches. In the emergence cage the winter mortality was 39.35 per cent which indicated that the beetles hibernated deeper in the loose soil.

HIBERNATION STUDIES, 1947–48.—cages used during the winter of 1947–48 were constructed of wood with a top covered with hardware cloth and hinged for opening. The cages were buried in the ground and then filled with the desired soil type. Five cages were used. Four contained different types of soil or surface cover and one was used for emergence given in table 3. It will be noted that in the cage containing hard, red clay soil no beetles were found below the 2-inch soil layer but in loose soil and sand they were found more than 6 inches deep in the ground. The winter mortality in the red clay soil (46.67) per cent was significantly greater than in the sandy soil (21.33 per cent). Very few beetles were found in cage 3 and undoubtedly they had been destroyed by some predaceous animal. Data in table 3 also indicate that beetles began emerging earlier from the sandy soil than from the red clay soil. The sandy soil was generally 2° to 5° F. warmer during March and April than the red clay soil which accounted for the difference in time and rate of emergence.

Plum curculio emergence data in the spring of 1947 and 1948 indicate that the beetles begin to emerge when the mean soil temperature at 3 inches reaches approximately 50° F. This temperature was reached on April 2, 1947, and the first beetles were found in the emergence cages the following day. In 1948 the 50° F. temperature was reached on February 25

and again a few beetles began to emerge the following day. Cold weather prevailed during the first 2 weeks of March and the beetles which had emerged went back into hibernation and did not begin to emerge again until March 21 when the mean soil temperature at 3 inches had been 50° F. for 2 days.

Table 2.—Depth of hibernation in soil of plum curculio adults during the winter of 1946–47.

Place of Hibernation	Number of Beetles Removed from—[1] Cage 1	Cage 2
Dead grass on surface	0	0
First inch of soil	4	27
Second inch of soil	28	19
Third inch of soil	9	2
Fourth inch of soil	7	2
Fifth inch of soil	1	0
Sixth inch of soil	1	0
Seventh to twelfth inch of soil	0	0
Total	50	50
Winter Mortality (per cent)	78.99	78.72

[1] Examinations were made on March 3, 1947.

DISCUSSION.—A review of literature produced one reference to beetles hibernating in the soil. It is probable that the beetles are able to winter under leaves and trash in Georgia where the winter weather is mild, but in Virginia and probably in states farther north the adults need more protection against the cold and have acquired a burrowing habit.

Observations over a period of years indicate that some plum curculio beetles seek hibernation quarters early in the fall. In 1946 a number of beetles were found on August 27 under debris in woods adjoining a peach orchard. It appears that as cool weather approaches the adults seek cover, usually in locations with the most moisture, such as grassy ditch banks, woods cover near streams, etc. At first the beetles remain in and under the surface cover but as winter approaches they burrow into the ground. In the spring when the soil has warmed to near 50° F. the beetles move up to the ground surface where they often remain for several days or a week with only their beaks projecting out of the soil. As the temperature rises the beetles emerge and enter the orchard. Spring rains stimulate large numbers of adults to activity since the rain warms the ground for several inches below the surface and it is easier for the beetles to burrow out through the moist soil.

More than 20 years ago the statement was made that winter burning of woodlands adjacent to peach orchards was an important supplementary control measure in plum curculio control and up to the present time the same recommendation is made. The data presented in this paper show that the majority of the adult beetles hibernate in the ground in Virginia. The hottest fires on the surface of the soil have not been sufficient even to warm the ground more than an inch deep and no beetles have been killed by experimental winter burning (January and February). From 25 to 40 per cent of the overwintering beetles may be killed by delaying burning until early spring (late March) but such burning is of doubtful value since it does not permit any reduction in the number of sprays which must be applied for plum curculio control. Spring burning may be of value as a supplementary measure in cases of very heavy curculio infestations.

Table 3.—Depth of hibernation in soil of plum curculio adults during the winter of 1947–48.

Place of Hibernation	Beetles Removed from—[1] Cage 1	Cage 2	Cage 3	Cage 4
Dead grass on surface	12[2]	3	1	38
First inch of soil	26	32	0	12
Second inch of soil	2	2	1	2
Third inch of soil	0	1	0	0
Fourth inch of soil	0	2	0	1
Fifth inch of soil	0	0	0	0
Sixth inch of soil	0	0	0	0
Seventh to twelfth inches of soil	0	1	1	6
Total	40	41	3	,59
Winter Mortality (per cent)	46.67	45.33	96.00	,1.33

[1] Examinations were made on February 26, 1948.
[2] Beetles covered with red clay indicating that they had been in ground.
Note: Cage 1 contained hard, red clay soil with grass and leaves on surface.
Cage 2 contained loose wood's earth with dead leaves on surface.
Cage 3 contained loose wood's earth with grass on surface.
Cage 4 contained sand with grass on surface.

SUMMARY.—The majority of the plum curculio adults hibernate in the second and third inch soil layers in Virginia. The beetles do not appear to be able to pass the winter under debris on the surface of the ground.

The adult beetles begin to emerge in the

spring when the mean soil temperature at 3 inches has reached approximately 50° F. The type of soil influences the time and rate of emergence since sandy soils warm more rapidly than red clay soils.

Winter burning of woodlands during the winter is of no value in plum curculio control. Early spring burning will kill many beetles and may be of value in cases of very heavy infestations.

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Resistance to Basic Lead Arsenate by the Peach Twig Borer Within a Small Area in Central California

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About 4 years ago an outbreak of the peach twig borer, *Anarsia lineatella* Zeller, developed in peach orchards within a small area near Empire, Stanislaus County, California. Prior to this time, growers in this locality obtained satisfactory control of the twig borer population by the application of two lead arsenate sprays.

Sometime during 1944, the twig borer population began to increase in this locality. In the three following seasons, 1945 to 1947, growers of cling peaches sustained serious losses on the later varieties such as Phillips. The average loss in the affected area was estimated to be near 20 per cent of the late cling crop, with an upper extreme of about 50 per cent. Additional cover sprays or dustings with lead arsenate provided some relief, but no combination of spray or dust treatments with this material, up to five applications, was wholly effective.

The persistance of a heavy population of the pest despite repeated applications of lead arsenate aroused the suspicion that the twig borers within this area had acquired in some degree, an immunity to this chemical (Bailey 1948).

The experiments presented in this report were performed to test the assumption that the twig borers at Empire are more resistant to lead arsenate than those existing elsewhere.

PROCEDURES.—Twig borer larvae of the "May" brood were collected from peach or almond twigs in two widely separated areas and reared in the laboratory. One batch of larvae was taken from young peach and almond orchards in the vicinity of Empire, in the heart of the area within which control with basic lead arsenate had been very poor. For comparative purposes, another batch of larvae was obtained from young almond orchards at Arbuckle, California. Arsenic sprays had never been applied to the trees in these orchards.

Moths derived from the two batches of larvae were placed in separate cages and provided with bouquets of cut peach twigs on which to lay eggs. Inasmuch as the timing of the May brood larvae differed for the two areas, one batch of moths (Arbuckle) began to oviposit several days in advance of the other. The daily batches of eggs deposited on the twigs were held at room temperature until embryogeny advanced to the brown-spot stage. They were then refrigerated at 41° F. and later used in rotation according to dates laid. As the experiments were set up, the duration of the refrigeration period varied from 2 to 15 days; and, when with-

drawn from storage, the refrigeration period for the Arbuckle eggs was 5 to 6 days longer than for the Empire eggs. While differences in this respect may have introduced a possible source of error, comparisons of the untreated samples do not show it to be important for the problem under consideration.

Green Elberta peaches were selected for freedom from blemishes and splits. One-half of these were set aside for use in the control experiments. The rest were dipped in continuously stirred suspensions of basic lead arsenate. The suspensions were made up in concentrations corresponding to 1.00, 2.00 and 4.00 pounds of lead arsenate (96 per cent active ingredient) per 100 gallons of water containing 0.1 per cent of a spreader.[1] Individual peaches were picked up in a wire cradle and dipped in the suspension 4 times in rapid succession. The dipped peaches were then dried on a wire grid and placed in pans provided with glass covers.

The egg-bearing leaves were cut into small pieces, each one having a small number of eggs. The pieces were laid on the peaches in such a way as to provide about 5 larvae per fruit.

Two days after the date of hatching, the number of eggs and the number of successfully established larvae were determined. The presence of active larvae within the fruit, or in shallow scarifications showing frass formation and webbing over was taken as evidence of successful establishment. Only about 50 per cent of the hatching larvae were able to establish on untreated fruits. Practically all of these entered the peaches at the stem or calyx end. Less than 1 per cent of the larvae perforated the intact epidermis.

RESULTS.—The data compiled in table 1 show that the larvae derived from the two groups of moths can be differentiated in respect to their susceptibilities to lead arsenate. A consistently higher percentage of Empire larvae establishing on treated fruits indicate that fewer of these than of the Arbuckle larvae are susceptible to lead arsenate. However, the difference obtained between the two lots of larvae are statistically significant in only 4 out of the 5 trials. As determined by a chi-square method (Snedecor 1946, p. 194), the observed differences between the

[1] *Vatsol OT.*

Table 1.—Penetration of *Anarsia* larvae into peaches dipped in suspensions of basic lead arsenate (July 6 to July 17).

Pounds Lead Arsenate per 100 Gallons	Source of Moths: Arbuckle		Empire		Chi-squares
	Number of eggs hatched	Larvae established	Number of eggs hatched	Larvae established	
1	166	11.3%	73	30.2%	8.68[1]
0	108	38.0	82	47.6	1.41
2	152	6.6	127	18.9	8.63[1]
0	120	50.0	119	44.5	0.53
4	105	2.9	104	34.6	32.62[1]
0	107	41.2	91	47.3	0.53
4	86	12.8	125	20.0	1.393
0	69	50.7	136	44.1	0.56
4	104	2.9	120	12.5	5.73[2]
0	77	45.5	101	39.6	3.33

[1] P<.01.
[2] P=.01–.05.

numbers of larvae establishing on the treated fruits are very significant for the first 3 trials, significant at the 5-per cent level in the fifth trial, and of doubtful significance on the fourth.

No distinction can be made between the penetration of Arbuckle and Empire larvae into the untreated fruits in any of the trials. Considering the possible sources of variation, the range of percentages obtained for the controls was surprisingly small for samples of this size.

These data fail to show that mortality increased as the amount of lead arsenate in the dipping bath was increased. This probably relates to the method of application. The method of dipping rather than spraying was chosen in the belief that a more thorough coverage would be obtained, especially around the irregularities on the depressed calyx ends of the fruits. Whether or not the deposit of poison on the surface of the fruits increased in proportion to the quantity added to the dipping bath was not determined.

DISCUSSION.—This experiment tends to confirm the assumption already made by Empire peach growers that the resistance of the peach twig borer populations to lead arsenate has increased. The recent outbreak of this pest at Empire therefore appears to have arisen in consequence of this occurrence.

The development of resistance to specific insecticides already has been reported for a number of insects in field or laboratory studies. The first report in this country was that of Melander (1915) on the varying susceptibilities of San Jose scale to lime sulphur sprays. Quayle (1922, 1938), Dickson (1941) and Dickson &

Lindgren (1945, 1947) made extensive studies of HCN resistance on the red scale, *Aonidiella aurantii* (Mask.), in many parts of California. Variations in the response of the confused flour beetle, *Tribolium confusum* Duv., to HCN were recorded by Gough (1939). Arsenic resistant strains of the codling moth have been investigated in detail by Hough (1928, 1929, 1934). Differences in the tolerance of screw-worms to phenothiazine was noted by Knipling (1942), and a laboratory strain of houseflies resistant to DDT was developed recently by Lindquist & Nelson (1948). This record of resistance of the peach twig borer to lead arsenate adds another case in point to the growing list.

Each new instance reported tends to emphasize the growing need for more investigations concerning fundamental aspects of acquired resistance. The trend in insecticide development is, in general, towards greater toxicity, and the trend in insect control is towards use on an ever-expanding scale. Either or both may prove to be potent factors in accelerating the appearance of new resistant strains or races of insects. Research in this direction may yield dividends in the form of methods for circumventing those adaptations undesirable from the standpoint of insect control.

SUMMARY.—It has been found that basic lead arsenate no longer satisfactorily controls the peach twig borer in cling peach orchards near Empire, California. After four seasons of failure to hold the twig borer in check with two or more applications of lead arsenate, the peach growers of this area have assumed that the twig borer population has developed some degree of resistance to this material. Evidence which tends to confirm this assumption was obtained in the laboratory. It was found that hatching larvae obtained from moths collected at Empire establish on peaches coated with lead arsenate in greater numbers than do larvae from moths collected elsewhere.

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PACIFIC SLOPE BRANCH MEETING

"The thirty-third Annual Meeting of the Pacific Slope Branch A.A.E.E. will be held at Grand Canyon, Arizona on June 16, 17, and 18, 1949. Headquarters for the meetings will be at the Hotel El Tovar."

Oriental Fruit Moth Control with DDT[1]

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DDT was first reported to be toxic to the oriental fruit moth, *Grapholitha molesta* (Busck), by Driggers (1944) and Carman & Fleschner (1944). Their results were later confirmed by Wheeler & La Plante (1946). At present most of the growers in eastern New York are using DDT late in the season—that is, at the time second and third-brood larvae are active—to obtain control of the oriental fruit moth. Properly applied late-season DDT schedules have seemed to be more dependable in preventing injury by this insect than the parasite program in general use prior to the introduction of DDT. However, the control obtained has not always been so effective as desired, and sometimes DDT residues on harvested fruit have been high, especially when more than two applications were made or when the DDT was applied just prior to harvest. For these reasons, during 1948 the author investigated the possibility of controlling the oriental fruit moth with early-season DDT spray applications. Late-season DDT spray programs were also tested for comparative purposes. The objective was to develop a spray schedule that would suppress spring-brood moths and first-brood larvae to such an extent that treatment later in the season would not be necessary. The effect of the early-season DDT applications on other peach pests was also observed.

Yetter & Steiner (1932) showed that oriental fruit moths are strong fliers, presenting records of flights of marked moths up to distances of 6,500 feet. For this reason the suppression spray test made early in the season was set up in the J. B. Rhodes and Son orchard at Warwick, N. Y. This consisted of 325 Elberta peach trees located some distance from other peach plantings. All trees were sprayed from the ground with a conventional high-pressure sprayer and single-nozzle guns. Moth activity was measured by means of 10 1-quart bait traps in five trees located so as to represent trees from all parts of the orchard. The bait consisted of brown sugar and terpinyl acetate as developed by Chisholm *et al.*, (1946). Bait changes in the two traps in each tree were staggered so that a fresh solution was placed in one of the traps every 10 days.

The complete spray schedule used in the Rhodes orchard was as follows (quantities are for 100 gallons):[2] May 11, DDT, 2 pounds plus micronized wettable sulfur 5 pounds; May 20, DDT 2 pounds plus benzene hexachloride 3 pounds plus polyethylene polysulfide sticker 0.5 pound plus micronized wettable sulfur 5 pounds; May 28 and June 8, DDT 2 pounds plus benzene hexachloride 3 pounds plus micronized wettable sulfur 4 pounds; and August 11, a dinitro-*o*-cyclohexylphenol salt[3] 1.25 pounds plus 70 per cent sulfur paste 5 pounds. The first application, on May 11, was made about the time of petal fall. This date coincided with the date of peak moth captures for the spring brood, the first moths having been captured on April 27. The applications on May 20, May 28, and June 8 were timed primarily for control of the plum curculio, *Conotrachelus nenuphar* (Hbst). One prebloom sulfur spray had been applied by the grower before the orchard was taken over for experimental purposes. The dinitro application on August 11 was for the control of mites.

Twig and fruit injury was recorded throughout the season by removing infested twigs and fruit at 7 to 10-day intervals from 5 trees adjacent to trees containing baits in the Rhodes orchard. Oriental fruit moth injury was recorded at harvest (September 9–10) by recording visible injury from 300 peaches and invisible injury from 100 peaches from 8 trees selected at random throughout the orchard. Injury was then computed for the total crop on the trees. Moth captures, twig injury, and control obtained were compared in so far as possible with those occurring in an Elberta peach orchard on the Gerald Layton farm, approximately 2 miles from the Rhodes orchard, in which a late-season DDT schedule had been used for oriental fruit moth control. This

[1] Work reported herein was conducted at Poughkeepsie, N. Y., in cooperation with the New York (Geneva) Agricultural Experiment Station.

[2] Quantities given for DDT and benzene hexachloride are for 50 per cent wettable powders. The benzene hexachloride contained 6 per cent of the gamma isomer.

[3] *DN-111.*

schedule included the application of DDT sprays on July 1 and 14 for second-brood control and of a 5 per cent DDT dust on August 4 for third-brood control. Carry-over of larvae in the Rhodes orchard was lighter than that in the Layton orchard, fruit injury in 1947 having been between 20 and 25 per cent in the former as compared with at least 40 per cent in the latter.

A comparison of seasonal moth activity, as indicated by bait-trap catches, in the Rhodes and Layton orchards shows that in the Rhodes orchard more than 37 per cent of the total number of moths caught during the season, or 167, were captured before the first DDT spray application on May 11, whereas in the Layton orchard less than 17 per cent of the total were captured prior to that date. Daily moth captures in the Rhodes orchard dropped off immediately after the first DDT application, and only 12 moths were caught from that time to the end of the first-brood activity on June 24. First-brood moth activity was higher in the Layton orchard than in the Rhodes orchard, captures during that period representing 58 per cent of the spring-brood catch in the former and only 7 per cent in the latter. It is believed probable that much of this difference was due to the effect of DDT sprays on the moth population in the Rhodes orchard. Catches of moths through the remainder of the season in the Rhodes and Layton orchards were as follows:

Brood	Rhodes Orchard		Layton Orchard	
	Number	Per Cent of Total	Number	Per Cent of Total
First (June 25–July 25)	31	7	2067	34
Second (July 26–Aug. 22)	151	34	836	14
Third (Aug. 23–Sept. 29)	86	19	794	13

Larvae in the Warwick area began entering twigs on May 20, and twig injury, especially by the first and second broods, was severe in most orchards in that area. In the Rhodes orchard no injured twigs could be found on 5 trees prior to June 23, and no injured peaches were observed on these trees. Injured twigs from five trees totaled 7 for first-brood larvae, 26 for second-brood, and 4 for third-brood, or a seasonal average of 7.4 twigs per tree. Examinations were discontinued on August 31, because by that time twigs had hardened and all larvae hatching after that date entered the ripening peaches.

Infestation records taken at harvest time in the Rhodes and Layton orchard are given in table 1, together with similar data from plots in the Morehouse orchard. This orchard, which is located about 5 miles from the Rhodes orchard, had received a late-season DDT spray schedule for oriental fruit moth control. The data from the Morehouse orchard cover the Elberta variety in a block sprayed on July 1 and 14 with 2 pounds and on August 4 with 1 pound of 50 per cent DDT per 100 gallons. It is of interest that less than 1 per cent of the fruit was injured in the Rhodes orchard, which was sprayed early in the season only, and that 8.9 and 2.7 per cent, respectively, were injured in the Layton and Morehouse orchards, in which the treatments were applied later in the season.

Observations were made in the Rhodes orchard to determine the effect of the spray program on peach insects other than the oriental fruit moth and on mites that attack peaches. Plum curculio control was excellent owing to the inclusion of the three sprays of benzene hexachloride. Only a few injuries were observed and these were near one corner of the orchard close to a wooded area. Catfaced peaches, which are caused by sucking insects early in the spring and are present in most orchards, at least to a limited extent, could not be found. An occasional peach was found that nad been injured by the red-banded leaf roller, *Argyrotaenia velutinana* (Wlkr.). The percentage of peaches injured by this insect averaged 0.26 on the eight trees from which harvest counts were made. Injury from the Japanese beetle, *Popillia japonica* (Newm.), and the peach tree borer, *Sanninoidea exitiosa* (Say), was not enough to be of commercial importance. Since neither insect begins to emerge before July 1, it is not likely that the schedule used would be of value in controlling them.

Both the two-spotted spider mite, *Tetranychus bimaculatus* (Harvey), and the European red mite, *Paratetranychus pilosus* (C. & F.), were present in this orchard. Two-spotted mites were the more abundant and began appearing on the lower leaves near the center of the

trees about July 9. Populations of these mites seemed to build up in this orchard earlier in the season than in orchards where DDT was not applied prior to July 1. Mite populations became severe enough so that control measures were needed shortly after August 1. The dinitro spray applied by the grower on August 11 reduced them to a low level and kept them at such a level the remainder of the season. Brown rot control was better than that generally secured, possibly because of the excellent control of insects that cause injuries where brown rot infections often start, such as the plum curculio and the oriental fruit moth and insects that cause catfacing.

Table 1.—Effect of time of application on effectiveness of DDT treatments for oriental fruit moth control.

Time of Application, Orchard, and Schedule	Average Number of Fruits per Tree	Per Cent of Peaches			Average Number of Injuries per Tree
		Clean	Wormy		
			Visible	Invisible	
Early season:					
Rhodes—4 sprays	1029	99.3	0.2	0.5	7
Late season:					
Layton—2 sprays and 1 dust	617	91.1	6.1	2.8	63
Morehouse—3 sprays	1719	97.3	1.1	1.6	54

No observations were made relative to the effect of either DDT or benzene hexachloride on the parasites and predators of the oriental fruit moth that might have been present in the Rhodes orchard. Peach orchards in this area, except one or two where annual releases of *Macrocentrus ancylivorus* (Rohwer) are made, generally have very few parasites. Emergence of moths and parasites from twigs and peaches collected at 7- to 10-day intervals throughout the season in three other experimental orchards in the Warwick area was as follows: 205 moths and 3 parasites for the first orchard, 89 moths and 4 parasites for the second orchard, and 133 moths and 7 parasites for the third orchard—an indication of low parasitization.

Spray injury to the foliage was evident after the second application on May 20. This injury was attributed to the polyethylene polysulfide sticker included with the DDT, benzene hexachloride, and wettable sulfur. Injury first showed up in the form of red lesions on the leaves. These lesions later turned brown and the centers dropped out, leaving a shot-hole effect on the leaves. Leaf drop, which occurred in some instances, was most severe at the time of the third application, 9 days after the second. The combination dinitro and 70 per cent sulfur-paste spray applied on August 11 also caused injury to the leaves. This injury first showed up on August 17. The terminals and edges of some of the leaves appeared to be bleached and later the terminal ends dropped off, leaving a bob-tailed effect. A few leaves dropped.

The principal advantages of a heavy early-season DDT schedule for oriental fruit moth control are as follows:

(1) Sprays are applied at the time other materials are being used for the control of brown rot and plum curculio, so that the only additional cost is that of the DDT.

(2) Control of other insects, such as plum curculio and those that cause catfaced peaches, may be better than that obtained with the usual spray, and brown rot may be less serious because of fewer insect injuries in the fruit.

(3) If first-brood control of oriental fruit moth is unsatisfactory, additional DDT sprays can be applied later, whereas if a late-season spray schedule is inadequate, it is too late to apply additional sprays.

(4) Residues of DDT on harvested fruit are light, as compared with those from late-season sprays.[1]

(5) Trees can be covered more easily when foliage is light and the branches are not bent down with fruit.

The principal disadvantages of a heavy

[1] Analyses by A. W. Avens, New York Agricultural Experiment Station, showed that fruit picked at harvest averaged 2.1 ppm of DDT as compared with 6.9 and 7.8 ppm on fruit from Layton and Moorehouse orchards.

early-season DDT schedule are as follows:

(1) Orchard mites, especially the two-spotted spider mite, may build up earlier in the season so that special sprays will be needed for their control.

(2) The applications are made too early to be effective against the Japanese beetle and the peach tree borer, so that special applications are likely to be needed for these insects.

(3) Since there are four broods of the oriental fruit moth each season, sprays applied in late May and early June must be thorough enough to obtain the degree of control needed to prevent late-season increases to serious proportions.

In orchards that may become reinfested with the oriental fruit moth by migration from other orchards, especially adjacent orchards, careful watch must be maintained for late-season injury, and steps must be taken to prevent it if it threatens, provided dependence is to be placed on a first-brood schedule for control.

The results reported are for one season only, and further investigations are desirable before final conclusions are made. —Eastern Branch Program. 1948.

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SCIENTISTS AND RESERVE OFFICERS

The Department of the Army has established a program of particular interest to entomologists and other scientists who hold Reserve commissions in the Army, and who are professionally engaged in teaching or research and development.

The objectives of the program are to:

(1) Maintain the useful affiliation of entomologists and other scientists with the Organized Reserve Corps.

(2) Provide peacetime Reserve assignments for these officers, enabling optimum utilization of their education, experience and skills.

(3) Furnish mobilization assignments which will fully utilize their talents, and

(4) Adequately prepare these officers for mobilization.

The Technical Services of the Department of the Army submit to these Research and Development Reserve Groups research problems and projects which pose an intellectual challenge to members of the group. Thus, the program provides members of each group a type of training which is in keeping with their scientific and technical interests and competence, rather than a traditional kind of training session in which scientists have little or no interest.

The program is now being implemented only in those areas where there is a definite local interest. To date, eighteen Research and Development Reserve groups have been organized. Twelve additional groups are in process of organization. Others are in the initial stages of formation. Several of these groups have been formed in communities in which large universities, industrial research laboratories, or private research foundations are located. Typical localities are Chicago, Illinois; Wilmington, Delaware; Newark, New Jersey; Houston, Texas; Washington, D. C.; Manhattan and Lawrence, Kansas; Champaign-Urbana, Illinois; Pittsburgh, Pennsylvania; Denver, Colorado; and Detroit, Michigan.

Provision is made to submit research projects of interest to all categories of scientists—chemists, physicists, engineers, geologists, geographers, psychologists, mathematicians, and all of the biological scientists which will include entomologists.

Reserve officers who are currently engaged in civilian research, college or university teaching, or industrial research or development, or who in the past have had specific research experience are eligible to make application for assignment to an Organized Reserve Research and Development Group. A group may be organized in any locality where there are twenty (20) or more qualified officer scientists who desire to participate in the program. A subgroup may be organized with ten (10) qualified members.

The program is under the general direction of the Research and Development Group, Logistics Division, General Staff, United States Army. The entire program is outlined in Department of the Army Circular Number 127, dated 5 May 1948.

Inquiry about organization of an Organized Reserve Research and Development Group or about assignment to a group already organized should be made of the Unit Instructor, ORC, or of the Senior Army Instructor, ORC, in the locality in which the officer resides. In localities in which a group has already been organized, the Commanding Officer of the group will consider applications for assignment of additional officers

Red-Banded Leaf Roller Problem in New York

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Harman (1948) summarized the red-banded leaf roller situation in New York previous to and including 1947. He reported that normally each year there has been a small amount of fruit injury in western New York. Minor local outbreaks occurred in 1930, 1937–1938 and during 1946. Serious losses took place in 1947. Harman showed that DDT was inferior to lead arsenate for red-banded leaf roller control. He conjectured that the 1946 and 1947 outbreaks were permitted by the low potency of DDT against this pest and its toxic action against parasites and predators.

During 1948, the red-banded leaf roller continued to be a serious problem in many orchards and became severe also in areas not previously troubled. Infestations were spotted throughout the state with injury common in parts of the Lake Ontario fruit district and only somewhat less so in the Hudson Valley. Surveys made during harvest indicated that the outbreaks were not entirely confined to orchards where DDT was used, although there was a tendency for infestations to begin the year following its first use.

First brood red-banded leaf roller larvae have caused little fruit injury in previous years. However, in 1948 first brood larvae caused as much as 40 to 50 per cent fruit injury on unsprayed trees and commercial damage in many well sprayed orchards. The larvae fed on the leaves until the middle of June. From then on many moved onto the fruit, feeding between apples and under leaves which they webbed to the fruit. The injured areas gradually corked over. As the apples grew, they frequently became somewhat deformed.

The second brood larvae fed on leaves for more than a month and then, as in previous years, many of them moved to the fruit. The larvae were found almost exclusively on the undersides of the leaves until the end of August. During early September the larvae became restless and were commonly seen crawling about or spinning down from the trees. Many moved to the fruit and some moved to other leaves, feeding on the upper surface. The migration to the fruit was 2 weeks later than during 1947. The second brood feeding areas were the starting point for various rots and allowed rapid moisture losses. Any second brood injury threw an apple out of fresh fruit grade and made it unfit for storage. On the other hand, some processors were taking injured apples provided the injured areas could be peeled with not over 5 per cent loss. Many of the severely injured apples went for juice or were not sold. In orchards where the second brood larvae were abundant, 50 to 75 per cent of the fruit dropped prematurely and a large part of the fruit remaining on the trees was also injured.

Comparisons made with records taken in previous years showed the seasonal development of this pest in 1948 was not unusual. Moth flight for the first brood took place between the pre-pink and pink bud stages and practically all eggs were laid before the blossoms opened. Egg hatching started at the end of bloom for the apple variety McIntosh and continued for approximately 2 weeks. Most of the larval feeding on fruit occurred during the last two weeks of June. Pupation which occurred during July averaged about 10 day, in duration.

Moths producing the second brood appeared in mid-July and deposited their eggs on the upper surfaces of the leaves. The incubation period averaged 10 days. Egg hatching began about July 25, reached a peak the first week of August and was complete by August 20. Larval activity continued until the last apples were picked in early November. In Western New York there were only two broods although a partial third one developed in the lower part of the Hudson Valley.

The red-banded leaf roller was found on a wide variety of fruit and shade trees, ornamentals and herbaceous plants. There was no indication, however, that these played an important role in breeding high populations in apple orchards. During 1948, parasites, predators and disease were not important factors. A few parasites emerged from field collected first brood larvae, but not enough to give any measure of control.

An account of 1948 spray schedules and spraying methods is given below in the discussion of the 1948 control experiments.

1948 CONTROL EXPERIMENTS.—In New York up to 1946, thorough applications of lead arsenate in the calyx, 10-day and early cover sprays apparently gave satisfactory control of the red-banded leaf roller. Grower experience in 1948 showed that this program was not adequate to control first brood larvae during severe infestations, and some growers that have never used DDT experienced severe second brood damage. Control of the red-banded leaf roller in New York naturally divides into a first and a second brood program. Recent experience shows that first brood control alone may not be adequate to protect the fruit through harvest. During 1948 a first brood experiment was conducted at Waterport and second brood tests were made at Ontario and North Rose. Each of these is reported separately.

SPRAY MATERIALS.—The materials used in these experiments were as follows:

Lead arsenate, 50 per cent DDT wettable powder, lime, sulfur fungicide—standard brands and grades.

Chlordan—50 per cent wettable powder.[1]

Methoxychlor[2]—50 per cent wettable powder.

Dichlorophenyl dichlorethane[3]—50 per cent wettable powder.

Tetraethyl pyrophosphate[4]—liquid containing 25 per cent tetraethyl pyrophosphate and 30 per cent other related phosphates.

Parathion[5]—25 per cent wettable powder.

Petroleum oil—The product used in first brood tests met New York specifications for a "dormant superior oil." For second brood a lighter viscosity oil of same type was employed.[6]

WATERPORT PEST.—Fruit injury had been so severe in 1947 in the Rhode Island Greening orchard selected for this test that the apples were not sold. The trees were large and vigorously growing. Complete coverage required 35 to 40 gallons of spray per tree. The 1948 bloom was heavy and fruit set was uniformly good throughout. Egg deposition in the spring was heavy, uniform and virtually complete when the pink spray was applied. Four rows of trees were divided into plots ranging from two to eight trees. All sprays were applied from the ground with a spray gun at 450 pounds pressure, spraying first from the inside and then around the outside.

The materials used, the spray dates and the fruit injury are reported in table 1. Magnetic 70 sulfur was used as the fungicide by the grower in the pink spray and in the experimental applications in the calyx, 10-day and first cover sprays. Five applications of sulfur dust were made by the grower between the pink and calyx sprays.

Fruit counts were made from July 6 to July 8. The bulk of first brood larval feeding was over by that time. All the fruit from one quadrant of a tree was picked and examined for injury. All drops under the same quarter of the tree were also picked up and examined. Two trees were sampled for each plot except for numbers 9, 10 and 12, where one tree was examined. Three untreated trees scattered throughout the block were used as checks.

In scoring the fruit, three grades of injury were set up: light, moderate and heavy, according to the amount of feeding on each apple. The light injury probably would not be commercial at harvest time. The moderate and heavy injuries have been combined and are given in table 1 along with the total of all grades.

The data clearly show that parathion was outstanding. As low as 4.8 ounces of 25 per cent powder per 100 gallons (equivalent to 8 ounces of 15 per cent product) in two sprays gave virtually perfect control. Several higher dosages were tried but not counted because the control was similar. No foliage injury occurred where the 25 per cent material was used at 9.6 ounces or less in the clayx and 10-day sprays. At higher concentrations, parathion caused the leaves to be rolled, slightly limp and slightly dwarfed. There was no fruit injury even at the highest concentration used, 3 pounds of 25 per cent wettable powder per 100 gallons.

Lead arsenate at 3 pounds was only moderately effective, and only when used in four sprays. It reduced the amount or area of the feeding more than the number of injured fruit, as indicated by the fact that the commercial injury was much less than the total injury. Increasing lead arsenate from 3 to 6 pounds in the calyx

[1] Dow Chemical Co.
[2] Du Ponts.
[3] Rohm & Haas.
[4] California Spray Chemical Co.
[5] American Cyanamid Co.
[6] Socony Vacuum Oil Co.

and 10-day increased the control. From the lead arsenate series it is apparent that this material gave some control of first brood larvae when applied in the pink, calyx and 10-day sprays but not in first cover.

The excellent control obtained with DDT was unexpected in view of previous comparable to four applications of lead arsenate. Egg masses were taken from oil sprayed trees in Plots 11 and 12 and from check trees. The egg hatch is given in table 2, along with the per cent control efficiency calculated according to Abbott's (1925) formula. The high ovicidal action of this oil without causing commercial

Table 1.—First brood red-banded leaf roller control experiments at Waterport, N. Y., 1948.

Plot	Material and Quantity per 100 Gallons		Spray Dates: Pink 5/3	Calyx 5/28	10-Day 6/9	First Cover 6/21	Fruit Injury: Commercial Injury Per Cent	Commercial Injury Per Cent Control	Total Injury Per Cent	Total Injury Per Cent Control
1	Lead arsenate	3 lbs.	x	x	x	x	3.9	89.2	9.5	77.4
2	Lead arsenate	3 lbs.		x	x	x	11.4	68.5	19.1	54.6
3	Lead arsenate	3 lbs.			x	x	21.7	40.0	35.9	14.7
4	Lead arsenate	3 lbs.				x	46.8	0.0	51.8	0.0
5	Lead arsenate	3 lbs.	x			x	1.7	95.3	3.7	91.2
		and 6 lbs.		x	x					
6	Lead arsenate 2 lbs. +50% DDT	1 lb.		x	x	x	12.8	64.7	17.9	57.5
7	50% DDT	2 lbs.	x	x	x	x	2.8	92.3	4.1	90.3
8	50% DDT	4 lbs.	x	x	x	x	1.4	96.1	1.6	96.2
9	25% Parathion	4.8 ozs.		x	x		0.2	99.4	0.2	99.5
10	25% Parathion	9.6 ozs.		x	x		0.4	98.8	0.4	99.0
11	Petroleum oil	1 gal.	x				9.6	73.5	10.6	74.8
12	Petroleum oil	2 gals.	x				4.2	88.4	4.8	88.6
13	Check						36.2	0.0	42.1	0.0

experimental work and grower experience. Careful analysis of Harman's (1948) data shows that he did not use DDT in his tests previous to the first cover spray. By this time, the larvae are partially grown and well established in webbing. It seems likely that DDT in the calyx and 10-day sprays is very effective against the young larvae, killing them as they crawl from the egg masses on the trunks and larger limbs to the leaves. Also, in the early sprays it is possible to cover thoroughly the undersides of the leaves along the midveins. A combination of DDT and lead arsenate at reduced dosages did not show any advantage over either one alone.

The use of oil in the pink spray is questionable because of possible injury due to the combination with sulfur. At the 1 per cent level no immediate injury occured, although about six weeks after application there was considerable dropping of the small primary leaves. A 1 per cent oil applied at petal fall caused severe injury. It is significant to note that one spray of a 1 per cent oil gave control of fruit injury tree injury at 1 per cent warrants further study. If most of the first brood eggs are deposited before the pink spray each year, a 1 per cent oil would be valuable for use in orchards where heavy egg deposition had taken place.

NORTH ROSE EXPERIMENT.—A uniform block of R. I. Greenings was selected to determine the value of various insecticides against the second brood of the red-banded leaf roller. All trees had moderate to heavy crop. These rows were divided into five blocks. Each treatment was represented in each block by a single tree replicate. Single trees were judged to be sufficient because most of the eggs were deposited before the sprays were applied. Examination of the data substantiated this point.

The grower had used lead arsenate against the first brood with poor results. No effort had been made to cover the undersides of the leaves.

The experimental sprays were applied on July 28 and August 9. All plots except 9 and 12 were sprayed inside and outside

from the ground with a spray gun at 450 pounds pressure. Plots 9 and 12 were sprayed from the outside only.

Fruit injury records at harvest were taken using methods similar to those reported by Newcomer & Dean (1943). For each tree records were taken of the number of bushels of picked fruit and the number of apples in three representative bushels. Enough apples were taken out of each bushel to make a total of 300 apples, which were then carefully examined for injury. All drops were picked up and examined. From these data it was possible to compute the per cent injured fruit (picked, drop or both) and the total number of injuries per tree or per 100 fruits.

Table 2.—Ovicidal action of oil sprays applied in Waterport experiment, 1948.

Plot	Spray Material	Egg Masses Examined	Per Cent Hatch	Per Cent Efficiency
11	1% Petroleum oil	168	2.0	97.9
12	2% Petroleum oil	113	4.3	95.5
13	Check	161	94.1	0.0

The difference between first and second brood fruit injury was easily determined. Only second brood injuries were recorded. In addition to the number of injured apples, a record was taken of the number of feeding areas. In most cases these areas were distinct and each probably represented the feeding of one larva. On the checks and some of the poorer treatments the apples were almost peeled and the exact number of feeding areas was difficult to determine. Estimates on some of these were as high as 13, a figure in line with the number of larvae actually found on some dropped fruit. The total number of feeding areas per tree is thought to be a good index of the total number of larvae present within the range of 10 to 26 bushels of fruit per tree. There was no marked correlation between the number of bushels and the number of feeding areas except on trees bearing less than 10 bushels. Therefore, the data are expressed as the number of feeding areas per 100 apples.

There was no severe fruit drop in this block in spite of heavy injury. The larvae did not begin to migrate onto the apples until the first week in September and the apples were picked about two weeks later. Much additional fruit injury and dropping probably would have taken place had harvest been delayed or if the larvae had begun feeding on the apples two weeks earlier as in 1947.

The results of the North Rose experiment are given in table 3. It is readily apparent that methoxychlor, chlordan, tetraethyl pyrophosphate have little or no value for the control of red-banded leaf roller. Chlorinated camphene gave considerable control, but in view of the fact it does not show much value against other insects present at this time of year,

Table 3.—Second brood red-banded leaf roller control experiments at North Rose, N. Y., 1948.

Plot	Material and Quantity per 100 Gallons		Second Brood Cover Sprays 7/28	Second Brood Cover Sprays 8/9	Fruit Injured Per Cent	Fruit Injured Per Cent Control	Feeding Areas per 100 Fruits Number	Feeding Areas per 100 Fruits Per Cent Control
1	25% Chlorinated camphene	3 lbs.	x	x	11.5	69.3	15.1	77.9
2	50% Methoxychlor	3 lbs.	x	x	18.8	49.7	25.1	32.9
3	50% Chlordan	2 lbs.	x	x	32.8	12.3	59.6	12.6
4	20% Tetraethyl pyrophosphate	1 pt.	x	x	29.8	20.3	47.7	30.1
5	50% Dichlorodiphenyl dichloroethane	3 lbs.	x	x	0.1	99.8	0.1	99.9
6	Lead arsenate	3 lbs.	x	x	0.6	98.4	0.6	99.1
7	50% DDT	3 lbs.	x	x	9.2	75.4	10.6	84.5
8	50% DDT	3 lbs.	x		24.2	35.3	39.7	41.8
9	50% DDT (Tree sprayed from outside only)	3 lbs.	x	x	17.5	53.2	23.4	65.7
10	25% Parathion	0.5 lb.	x	x	4.3	88.5	4.8	93.0
11	25% Parathion	0.5 lb.		x	7.7	79.4	9.6	85.9
12	25% Parathion (Tree sprayed from outside only)	0.5 lb.	x	x	4.9	86.9	6.1	91.1
13	Check				37.4	0.0	68.2	0.0

it will not be considered further. Three pounds of 50 per cent DDT gave fair control when thoroughly applied in two sprays. When used in a single treatment or when sprayed from the outside only, the control was markedly reduced. Parathion at one-half pound of 25 per cent wettable powder in two applications gave good control. It is thought that a higher degree of control was not obtained because the residual action was not sufficient to kill late hatching larvae. It should be noted that a single application gave almost as good control as two and that when it was sprayed only from the outside of the tree, similar control was obtained. Three pounds of lead arsenate gave excellent control of the second brood, whereas control with three pounds of 50 per cent dichlorodiphenyl dichlorethane was almost perfect.

There was no fruit injury resulting from any of the treatments. There was appreciable foliage injury from the use of lead arsenate in the form of yellowing and early drop.

ONTARIO EXPERIMENT.—This test was made in a Ben Davis orchard in which all trees were quite uniform and were bearing a moderate amount of fruit. Six rows were selected and divided into five blocks just as at North Rose. Each treatment was replicated by a single tree in each block.

Against the first brood, the grower had made thorough applications of lead arsenate as follows:

Pink spray, May 12, 3 lbs. lead arsenate per 100 gallons
Calyx spray, June 4, 4 lbs. lead arsenate per 100 gallons
10-day spray, June 15, 3 lbs. lead arsenate per 100 gallons
First cover, June 26, 3 lbs. lead arsenate per 100 gallons
Second cover, July 15, 3 lbs. lead arsenate per 100 gallons

Table 4.—Second brood red-banded leaf roller control experiments at Ontario, N. Y., 1948.

Plot	Material and Quantity per 100 Gallons		Second Brood Cover Sprays 7/29	8/10	8/20	Fruit Injured Per Cent	Per Cent Control	Feeding Areas per 100 Fruits Number	Per Cent Control
1	50% DDT	2 lbs.	x	x		8.7	64.3	10.4	69.5
2	50% DDT	3 lbs.	x	x		6.7	72.7	7.2	78.9
3	50% DDT	4 lbs.	x	x		2.5	89.6	3.4	90.0
4	50% DDT	3 lbs.		x	x	9.5	61.0	12.0	64.8
5	50% DDT	3 lbs.	x	x	x	4.7	80.6	5.9	82.7
6	Lead arsenate	3 lbs.	x	x		1.9	92.1	2.2	93.5
7	Lead arsenate	3 lbs.	x	x	x	0.3	98.6	0.3	99.1
8	25% Parathion	¼ lb.	x	x		4.3	82.3	5.3	84.5
9	25% Parathion	½ lb.	x	x		5.7	76.8	7.2	78.9
10	25% Parathion	1 lb.	x	x		1.4	94.3	1.4	95.9
11	25% Parathion	½ lb.		x		3.8	84.4	5.0	85.3
12	25% Parathion	1 lb.		x		1.9	92.4	2.2	93.6
13	25% Parathion	1 lb.			x	1.3	94.5	1.6	95.3
14	50% dichlorodiphenyl dichloroethane	2 lbs.	x	x		0.0	100.0	0.0	100.0
15	50% dichlorodiphenyl dichloroethane	4 lbs.	x	x		0.3	98.9	0.3	99.1
16	Petroleum oil	1 gal.	x	x		4.9	79.8	5.0	85.3
17	Check					24.4	0.0	34.1	

The same equipment and spraying technique were used in this test as in the others. The spray dates were July 29, August 10 and August 20. The spray schedule for each plot is shown in table 4. The same method of taking harvest records was used here as at North Rose.

The results are given in table 4. In general, the injury in the Ontario orchard was lighter than at North Rose even though egg deposition was heavy in July and early August. It is thought that the heavy lead arsenate residues on the undersides of the leaves may have been a factor in reducing the second brood population. Dichlorodiphenyl dichlorethane and lead arsenate were again outstanding. Two pounds of 50 per cent dichlorodiphenyl dichlorethane wettable powder per 100

gallons gave as good control as 4 pounds and gave the best results in this test.

In the dosage series of DDT, it can readily be seen that two pounds of 50 per cent wettable powder is not enough. Probably 4 pounds should be used to give satisfactory results. It is interesting to note that a third application was little or no more efficient than two applications. Also, two applications made August 10 and 20 were less efficient than two made on July 29 and August 10. The later dates correspond with the usual second brood codling moth sprays in New York and may account for in part the poor control of the red-banded leaf roller obtained with DDT in previous years. Also of importance may have been poor coverage.

Parathion again gave good control but inferior to lead arsenate and dichlorodiphenyl dichlorethane at the strengths used. It should be noted that one application was as effective as two. Plots 12 and 13 show that exact timing is not essential with parathion. Larvae in the early instars are readily killed even though under webbing.

A 1 per cent oil in two applications gave a considerable degree of control. However, it could not be considered commercial in a severe infestation. Although no foliage injury occurred in these tests, the possibility of sulfur-oil injury is always present. The finish of the apples treated with oil was dull compared to other treatments.

DISCUSSION.—Previous to the advent of DDT and its widespread use in apple orchards in New York during 1946 and 1947, most growers applied lead arsenate in several thorough applications to check serious codling moth damage. The data obtained in 1948 show that such a program would probably check and nearly eliminate any second brood leaf roller infestation that might carry over to the following year to give serious first brood injury. DDT was so effective against codling moth that the growers tended to ease off on thoroughness and frequency of application. In general, DDT was not used until the first cover spray or about the middle of June. The data show that applications of two pounds of 50 per cent DDT wettable powder per 100 gallons as commonly applied in a codling moth program would not give adequate control of the red-banded leaf roller. Also, the two applications of lead arsenate made by most growers in the calyx and 10-day sprays would not be very effective against this insect in the first or second brood. This lack of any effective chemical control plus the probable reduction of parasites is thought to account for the severe infestation in New York.

Although a lead arsenate program used regularly should give adequate control, it has several disadvantages. Frequent and thorough applications cause considerable foliage injury on some varieties and would give residues over the official tolerance. Furthermore, it would not give adequate codling moth control in many orchards. Many growers experienced considerable injury from this pest in 1948 with a lead arsenate program after 1 or 2 years of successful control with DDT. Spiking lead arsenate sprays with DDT would be expensive. For the future, a DDT program for codling moth control plus the addition of dichlorodiphenyl dichlorethane or parathion in one or more sprays is indicated.

SUMMARY.—The seasonal development of the red-banded leaf roller for 1948 is reported. It is shown that 1948 was probably not unusual. This pest was again serious in many apple orchards along Lake Ontario and also in the Hudson Valley. Unlike previous years, the first brood larvae caused severe injury to the fruit.

Control studies against first brood showed that parathion was outstanding, giving excellent results at strengths as low as four ounces of 25 per cent wettable powder per 100 gallons. It was also found that DDT at 2 and 4 pounds of a 50 per cent powder per 100 gallons applied beginning in the pink spray was very effective. Lead arsenate was less effective against first brood than DDT. A 1 per cent superior oil applied in the pink spray gave control comparable to four applications of 3 pounds of lead arsenate.

Against second brood red-banded leaf roller, chlordan, methoxychlor, tetraethyl pyrophosphate were found to be worthless. Chlorinated camphene gave fair control. DDT at 3 pounds of 50 per cent wettable powder per 100 gallons in two applications gave fair control when properly timed and thoroughly applied. Parathion gave similar control with a single application.

Proper timing was shown to be less important with parathion than DDT. Lead arsenate at three pounds and 50 per cent dichlorodiphenyl dichloroethane wettable powder at 2 pounds per 100 gallons gave the greatest reduction of second brood fruit injury.

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The Omnivorous Leaf Tier in California[1]

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This insect, which is commonly known as the omnivorous leaf tier, has long been recognized as an economic pest in Europe having been described in 1811. It was first discovered in the United States tunneling into strawberries and Dutch iris in Oregon in 1929. In 1934 it was reported from Washington (Edwards *et al.* 1934) with some account of its habits.

In the latter part of April 1948, Mr. J. J. McNamara, the farm advisor of San Mateo County, California, notified the author that small lepidopterous larvae were doing considerable feeding in a flax field near Palo Alto, Santa Clara County. Examinations of three fields in that area revealed the presence of the omnivorous leaf tier, *Cnephasia longana* (Haworth), in all fields examined. In adjacent San Mateo County, where considerable flax is grown, one field was found with a very light infestation. A very reliable and observant flax grower in the Pescadero area of San Mateo County informed the author that he has observed similar injury on flax continuously since 1942.

This insect received its common name of omnivorous leaf tier because of the characteristic leaf tying habit and cosmopolitan tastes of the larvae which according to Edwards and Mote (1936) involve 29 common plants belonging to 12 plant families. Some of the more important recorded hosts are, without attempting to enumerate in order of importance,—strawberry, Dutch iris, flax, peas, wheat, hops, filbert, clover, vetch, cultivated flowers, and alfalfa.

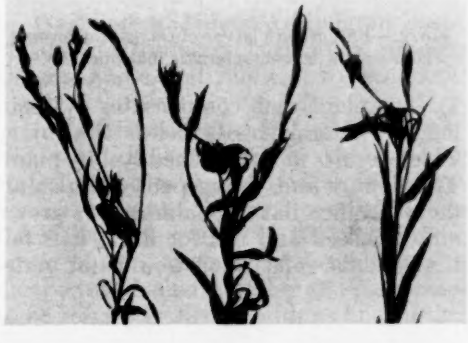

FIG. 1.—Flax plants infested with larvae of *Cnephasia longana* (Haw.) showing typical distortion.

In addition to the hosts listed by Edwards and Mote, the larvae have been collected in San Mateo County from gladiolus by the author in 1947, and from batchelor button, marguerites, heather, and calla lily by Mr. I. J. Campbell in 1948. The presence of the omnivorous leaf tier on cultivated flowers in the center of an extensive floriculture area is very disturbing, especially since no control methods are as yet known.

When the first extensive survey was made on April 20, 1948, approximately 30 per cent of the flax plants in the Palo Alto were found to be infested. At this time the flax was just coming into bloom and many of the larvae were in the fourth and fifth instars. The injury on flax is very characteristic and consists of webbing and feeding on the tender terminal leaves which bend over and cease growth (Fig.

[1] Presented June 16, 1948, at the Vancouver meetings of the Pacific Slope Branch, American Association of Economic Entomologists.

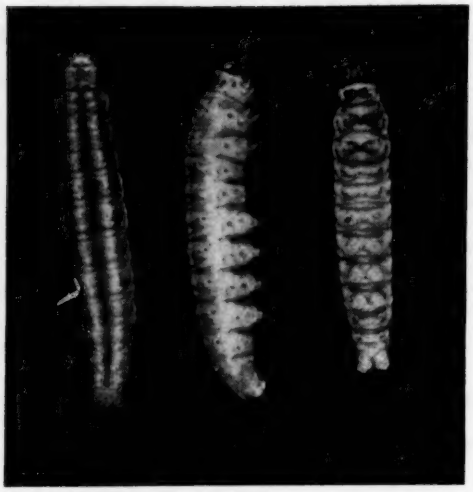

FIG. 2.—Full growth larvae of *Cnephasia longana* (Haw.) showing characteristic markings. (×4).

1). The plant then compensates by sending out lateral shoots below the injury which results in a shortened stubby plant. The flowers and young pods are also attacked. Since flax in California is grown only for seed and not for fiber, it is felt that a light infestation would not materially reduce the seed yield because of the additional lateral shoots which flower and produce seed.

On April 26, 1948, the Palo Alto fields were again examined and at this time many of the larvae had matured (Fig. 2) and left the plant for pupation. Larvae were collected for laboratory rearing by sweeping the plants with an insect net, averaging two larvae per sweep. No pupae were collected by examination of plants, in soil samples, or by sweeping on this or subsequent surveys. This species is reported in the literature to pupate within the nest.

Larvae which were collected on April the 20th and placed in rearing cages in the laboratory began pupating April 24 and the first adults (Fig. 3) appeared 9 days later on May 3. No difficulty was experienced in rearing numerous adults. By May 6 many of the larvae had left the plants for pupation and 200 sweeps yielded 178 fully grown larvae.

No parasites were recovered from the larvae brought into the laboratory. In some localities in Oregon, parasitism has been observed to reach approximately 20 per cent.

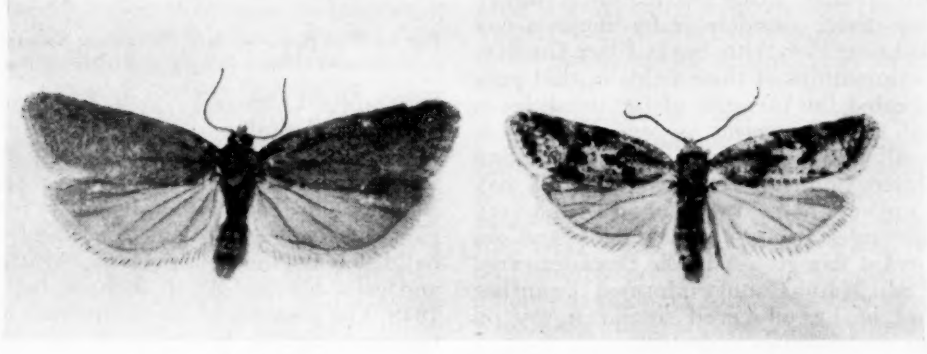

FIG. 3.—Adults of *Cnephasia longana* (Haw.): left, male; right, female. (×3).

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Life History and Control of the Orange Tortrix in Oregon[1]

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The orange tortrix, *Argyrotaenia citrana* (Fernald) is normally a minor greenhouse pest in Oregon. In June of 1947 it appeared in Oregon fields in serious numbers on raspberries, Boysenberries and blackberries. The growers applied DDT rather generally but the infestation continued and entomologists were called on for assistance.

The orange tortrix was described by Fernald, 1889, who placed it in the genus *Tortrix*. He received specimens from Coquillett who had reared them from oranges in California. Fernald also received specimens from *Solidago* and willow. In 1894 Coquillett reported the tortrix as burrowing into green oranges in California. He first received specimens of the pest in May 1885. He found the tortrix also on apricot, oak and wild walnut. In 1910 Quayle reported the tortrix to be injuring oranges and numerous greenhouse plants in California. He briefly described the eggs and larvae and the injury. Basinger & Boyce used cryolite as a control measure in 1936. In the same year Lange (1936) reared the insect and found 2 generations annually on Monterey pines. He found 5 larval instars but did not give the head capsule diameters. In 1938 Basinger did some important work on the biology and economic importance of the tortrix. He reviewed the literature and gave a long host list which he considered incomplete. He found two broods in the areas distant from the coast of southern California while along the coast the broods overlapped. The larval instars varied from five to seven or more. He recorded four important Hymenopterous parasites. Freeman revised the taxonomy of *Argyrotaenia citrana* in 1944 and gave its distribution as from California, on citrus, to British Columbia, in greenhouses. In 1947 Boyce & Ortega distinguished the work of the tortrix on oranges from that of other Lepidoptera and worked out seasonal control measures with cryolite on different varieties of oranges.

The history of the orange tortrix in the Pacific Northwest has been short. Dr. Webster[3] tells of the work of Mr. W. W. Baker[4] who reported that orange tortrix larvae were found on raspberries near Seattle in 1932 but the first adult was not reared and determined until 1938. Since the last date orange tortrix larvae have occasionally infested raspberries, Loganberries and evergreen blackberries on Vashon Island and in the Puyallup region of Washington. Other Washington hosts of the tortrix are cultivated grapes, Oregon grape and numerous greenhouse plants.

In the first report of the orange tortrix in Oregon, Zeller & Schuh, 1944, it was stated to be a general feeder in greenhouses and occasionally on cane berries in the Willamette Valley. In 1947 the tortrix appeared on Oregon cane berries in the northern Willamette Valley and continued to be serious in 1948. So far as known the distribution of the orange tortrix is limited to the western parts of the states of Washington and Oregon and to California.

In Oregon the larvae overwintered from mid-September to mid-March in different sizes beneath leaves caught on thorns of berry canes and in cane galls. On raspberries the overwintering larvae were in small cavities just below the buds on the canes. The larvae did a little feeding on warmer winter days on the outer green surface of the canes beneath their dead leaf shelters. The leaf-covered portions of the cane surfaces were green while exposed cane surfaces were brown during the winter. The feeding caused irregular brown stripes to appear on the surface of the canes but did not seriously injure them. The larvae spun a slight rough silken web around their wintering place beneath the leaves which served further to fasten the dead leaves to the canes. In March the larvae left their shelters and

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[3] Personal communication, 1948.

[4] Member of the USDA, Bureau of Entomology and Plant Quarantine, in 1932.

fed on the developing buds and leaves. They ate out the inside of the buds and often destroyed three or four before they found a partially developed leaf to feed on. They pulled the edges of the tender leaves together and then fed between the protecting surfaces. The larvae ate tender terminal foliage and flower buds until the berries were ripe and then some of the

Table 1.—Orange tortrix trap results in 1947.

Attractant	No. Traps	Av. Moths per Day per Trap	
		Females	Males
Oriental fruit moth bait	4	0.25	0.03
Jap beetle liquid bait (geraniol)	1	0.007	0.0
Jap beetle solid bait (geraniol)	1	0.007	0.0
Blackberries crushed+yeast	2	1.10	0.24
Kerosene lantern trap	3	2.20	19.25
Gasoline lantern trap	3	1.74	10.81
Codling moth bait	4	0.63	0.15
Apple juice+yeast	2	0.71	0.18
Peach juice+yeast	2	0.58	0.16
Boysen juice+yeast	4	1.25	0.24
Blackberry juice+yeast+sucrose	2	0.31	0.03
Blackberry juice+sodium benzoate	2	0.25	0.03
Honey 5% in water	2	1.17	0.33
Water only	2	0.10	0.50
Peach juice+yeast+sucrose	2	0.42	0.06
Peach juice+sodium benzoate	2	0.36	0.18
Molasses 1 pt.+H_2O 4 pts.	2	0.25	0.10
Ethyl alcohol 5% in H_2O	2	0.20	0.05
Methyl isobutyl ketone 5% in water	2	0.0	0.0
Secondary butyl alcohol 5% in water	2	0.35	2.65
Beer—fresh	2	0.95	0.25
Kerosene	2	0.15	0.05

large and small larvae bored into the base of the berries and fed on the fruit tissue. They generally spun a small amount of silk behind them so that the calyx of the berry or a nearby leaf was fastened over their entrance hole. The larvae have been found in blackberry, Loganberry, Youngberry, and Boysenberry foliage and fruit. They have not been found in red raspberry fruits but get into the picking boxes accidentally in harvesting. The larvae drop on a silken strand when they are disturbed and the pickers contact the silk as they pick the raspberry fruit.

The broods overlapped so that all stages were present in the fields during the summer. The pupae were usually found in webbed leaves of the cane berries but sometimes they were in fruit or in tangled debris in the twig axils or among dead leaves on the ground.

The tan-colored adults were crepuscular and flew along the berry rows from 8 to 11 P.M. on warm summer evenings when the air was still. They were slightly attracted to gasoline or kerosene lantern traps as shown in table 1. The light traps and baits were used in attempting to determine the timing and number of broods of moths. They were distributed evenly through the fields so that their effects did not overlap.

Table 2.—Chemical tests on the orange tortrix applied July 30.

Treatment	Worms per Crate of Berries			
	August			Av. per cent control
	4	11	18	
None	2.8	1.8	5.7	—
Rotenone—3% dust	1.2	0.9	1.9	67.7
Dichlorodiphenyl dichloroethane—5% dust	0.0	0.0	0.27	95.4
Cryolite—40% dust (36% Na_3AlF_6)	0.64	0.38	0.33	94.4
None	2.9	1.8	3.6	—
DDT—4%—dust plus sulfur 85.5%	1.0	1.3	3.0	49.1
DDT—5% dust	4.3	1.6	1.7	71.1
None	2.1	0.76	0.6	—
Light medium oil emulsion[1]—3% spray	1.7	1.4	1.2	79.6
50% DDT 5 lb.—100 gal. plus 3% oil emulsion[1] spray	0.42	0.9	2.3	61.0
None	2.6	3.1	14.0	—

[1] The light medium oil emulsion was 87% oil with a U.R of 92%.

The oriental fruit moth bait consisted of 147 pounds liquid diamalt, 2 pounds terpinyl acetate, 9 ounces bentonite and 12 ounces sodium benzoate in 300 gallons of water. The codling moth bait was molasses—1 pt. sodium benzoate 0.2 per cent and water 10 pts. A pint of liquid was used in each bait pot and in some cases, indicated in table 1, a gram of baker's yeast, a teaspoonful of sucrose or a quarter gram of sodium benzoate was added to the bait. The bait traps were quart-size asphalt and cloth florist pots which were suspended from the canes by wires. Each light trap had a tin hood around its top and a tin funnel beneath the lantern. The moths flew to the light and some of them dropped through the funnel into a pint jar containing carbon tetrachloride in absorbent cellucotton. Each evening's catch was removed and counted on the following morning. Table 1 shows that the light traps caught mostly male moths. In the preliminary trap and bait study none of the attractants was consistent enough to use in determining the brood populations.

Preliminary chemical control studies were made in July and August in the vicinity of Gresham, Oregon. Basinger & Boyce, 1936, found cryolite very effective in California in controlling the tortrix on oranges so it was included in the early

tests reported here. The early Oregon field tests were carried out on Himalaya blackberries thoroughly infested with orange tortrix in all stages. A power duster with 3 nozzles on each side was used to apply the dusts at the rate of 50 pounds per acre. Sprays were applied at a pressure of 250 pounds with a power take-off orchard type spray machine. The sprayer had one nozzle directed upward and one downward on each side of the machine. About 150 gallons of spray per acre was applied evenly in each application. In measuring the effect of the chemicals the worms in the crates of picked fruit in each treated row were counted. Each treatment was isolated by one or more rows of untreated buffer plants. Per cent control was based on the average number of worms in the untreated rows compared with the respective treated rows.

Table 3.—Chemical tests on the orange tortrix applied August 7.

Treatment	Worms per Crate of Berries		
	August 11	August 18	Av. per cent control
None	2.1	2.0	—
Rotenone—1% dust	0.37	1.2	64.7
Chlordan—5% dust ($C_{10}H_7Cl_5$)	0.25	2.0	41.1
None	0.25	1.0	—
Dichlorodiphenyl trichloroethane —5% dust	0.1	0.0	100.0
None	2.8	0.9	—
5%—dichlorodiphenyl trichloroethane 4 lbs.—100 gal. plus 1% light med. oil emulsion spray	0.73	3.12	8.2
5%—dichlorodiphenyl trichloroethane 8 lbs.—100 gal. plus wetting agent[1]—spray	3.1	0.6	82.3
None	3.7	9.7	—

[1] *Tergitol penetrant* 7 was used at 6 ounces per 100 gallons as a wetting agent.

Table 2 showed the chemicals dichlorodiphenyl dichloroethane and cryolite to be very effective. No leaf or berry injury was found throughout the trials in 1947–48. An average of 13.6 crates of berries was picked per row Aug. 4, 9.1 on Aug. 11 and 6.3 on Aug. 18. The per cent control in table 2 was based on Aug. 18 data compared to the average of the untreated plots.

A second series of chemical control tests was carried out on another field of blackberries. This test was carried out just as the first one except that there were fewer berries on the plants. An average of 7.3 crates per row were picked Aug. 11 and 4.3 on Aug. 18. Per cent control in the second table was based on Aug. 18 data compared to the untreated plot average.

The 5 per cent dichlorodiphenyl trichloroethane dust was again very effective. This strength was all that was available for use in sprays. The poor results of these sprays were probably due to the slight amount of the insecticide present.

In 1948 chemical testing was resumed with emphasis on dichlorodiphenyl trichloroethane and other new chemicals in comparison with cryolite and rotenone. Applications were made as before except that 350 lbs. pressure was used on the power sprayer with a 4 nozzle upright boom on each side. Larvae recorded in tables 4 and 5 were counted after treatment on each side of treated rows and the counts were averaged for the table data.

Table 4.—Effect of dusts applied May 7 on *Argyrotaenia citrana*. Number of larvae per side of a 75-yard row.

Dusts Used	Live Larvae May 14	Per Cent Control
None	5	—
Cryolite 70%	7	45.4
Dichlorodiphenyl trichloroethane —2%	1.2	90.7
Dichlorodiphenyl trichloroethane —5%	0.7	94.5
None	11.7	—
Dichlorodiphenyl trichloroethane —5%+25% sulfur	2.7	78.9
None	22.5	—
Chlordan—5% ($C_{10}H_8Cl_8$)	8.5	33.6
None	12.1	—
Ditolyl trichloroethane—5%	3.3	74.2
Chlorinated camphene—10%	2.3	82.0
Control average	12.8	—

Note—The larval populations from each side of 2 rows 75 yards long were averaged for the May 14 data.

The results shown in table 4 indicate that dichlorodiphenyl dichloroethane was considerably more effective than cryolite or some of the newer insecticides. A series of chemicals were also tested in spray form with particular attention to the combination of the chemicals in an oil emulsion as Basinger & Boyce (1936), had good results with oil added to cryolite.

The two untreated plots in the May 10 series averaged 50.5 larvae. The larval population from each side of a 65 yard row and one side of an adjoining 65 yard row were averaged to obtain data for May 15. The oil used was an 87 per cent

light medium oil emulsion with an unsaturated residue of 92 per cent. The addition of the oil to the various chemicals did not appreciably increase insecticidal effect except for rotenone where 2 quarts of oil nearly doubled the efficiency.

The best of the materials listed in the table 5 was dichlorodiphenyl trichloroethane as was the case in the other tests.

Table 5.—Effects of sprays containing oil on *A. citrana* applied May 10.

Spray Used per 100 Gal. Water	Per Cent Larval Control May 15			
	Chemical alone	Plus 1 qt. oil	Plus 2 qt. oil	Plus 4 qt. oil
Rotenone 2.5%—2 pts.	39.4	62.3	74.2	—
Dichlorodiphenyl trichloroethane 50%—2 lbs.	97.4	—	93.8	98.8
Cryolite—87%—3 lbs.	79.6	—	65.1	80.1
Parathion—15%—1 lb.	77.6	—	81.5	77.6
Chlordan—44%—4 pts.	86.1	—	70.2	91.4

In a community field test of the effect of this material about 500 acres of infested cane berries were treated in 1948 for orange tortrix control. The material was used at the rate of 1 and 2 pounds of 50 per cent wettable powder to 100 gallons of water in a spray or at 40 pounds per acre of the 5 per cent dust in early May. In later pre harvest sprays the chemical was reduced to 1 pound per 100 gallons. In all the dilutions it gave good commercial control measured by cannery inspection at harvest time.

The fields that were most heavily infested in the fall of 1947 by orange tortrix had been treated during the spring with two different sprays containing 4 pounds of 50 per sent wettable DDT to 100 gallons of spray. DDT was not very effective in controlling the tortrix in fields or row plot as indicated by results in table 2.

Moths were placed on treated paper surfaces 45 days old in a laboratory test of the residual effect of dichlorodiphenyl dichlorethane dust and spray. The moths were all dead on the second day of exposure while untreated adults similarly caged lived 5 days.

Among the hymenopterous parasites reared from the orange tortrix *Apanteles aristoteliae* Vier. made up 21 per cent of the population, *Itoplectis obesus* Cush., 17 per cent and *Horogenes eureka* Ash., 16 per cent. Basinger (1938) found *A. aristoteliae* to be the most important of the California tortrix parasites and it was the only one he mentioned that was also found in this study in Oregon.

SUMMARY.—Life history and control studies were carried out in 1947 and 1948 against the orange tortrix. Its host list was extended to include raspberries, Youngberries, Boysenberries, Loganberries and blackberries. Larvae fed on the berry leaves and, as the fruit ripened, some of the worms bored into the berries. The larvae overwintered in various sizes beneath dead berry leaves caught on the canes or in cane galls. They did a little feeding on the epidermis of the canes on warm winter days. Adult moths were crepuscular. Numerous attractants were tested on the adults, but only kerosene and gasoline light traps were even moderately effective. Chemical control tests in 1947 indicated that dichlorodiphenyl dichloroethane was effective. This was confirmed the next year when extensive field tests were conducted. DDT did not control the tortrix larvae.

The hymenopterous parasite *Apanteles aristoteliae* was common. *Itoplectis obesus* and *Horogenes eureka* were also important in natural control.

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The Grape Mealybug on *Taxus* in Ohio

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The earliest record of the grape mealybug occurring on *Taxus* in Ohio appeared in 1938 when infested twigs were received in a letter from Canton. In answering the letter, Professor J. S. Houser made the statement, "Yew is not commonly susceptible to attack by these insects." At that time *Taxus* seemed relatively free from insect attack, but since 1943 the grape mealybug has become a troublesome pest. It causes most concern in nurseries, but is also troublesome in ornamental plantings. No *Taxus* species has been observed to escape attack, but the most severe infestations have occurred on the more dense and compact types.

A review of the literature shows that this insect is very widely distributed. It has been recorded from several countries of South America, South Africa, Europe, and Canada as well as from all parts of the United States. Tate & Poor (1937) state that it has been recorded on more than 100 different host plants. Its life history on grape in Michigan as recorded by Pettit (1933) and Gentner (1935) is similar to that observed on *Taxus* in Ohio. However, the Michigan entomologists state that the insect winters in the egg stage, whereas on *Taxus* in Ohio the only living forms found in very early spring over a period of 4 years were first instar mealy bugs.

The *Taxus* mealybug, *Pseudococcus cuspidatae* Rau, as reported by Hamilton (1942) also winters in the first instar on *Taxus* in New Jersey, and apparently its work is similar to that of *P. maritimus*. However, it does not lay eggs, but gives birth to living young. It has not been recorded in Ohio.

Investigations of the biology and control of *Pseudococcus maritimus* on *Taxus* were undertaken in Ohio in 1944 and have been continued in a limited way since that time.

Biology—In order to determine the life history of this insect, three heavily infested plants of *Taxus brevifolia* were taken from nurseries in northern Ohio and planted at the Experiment Station where frequent observations could be made. Information obtained from these plants was checked by occasional observations infested nurseries.

The insect lives over winter in the first instar within the shelter of a mass of white waxy threads produced by the parent female, and is further protected by bits of dead foliage, scales of bark, and other debris webbed together. Most of these occur

Fig. 1.—Mealybug infestation on *Taxus*. May 28, 1945.[1]

in the interior of the plant near the main stem (Fig. 1). During April and May the tiny mealybugs leave their winter quarters and establish themselves on twigs where they feed.

The adult stage is reached during the latter half of June when eggs are deposited in masses of white fibrous material. Newly hatched crawlers of the summer brood have been observed as early as June 28,

[1] Specimens collected on *Taxus* at Painesville in 1940 were identified by Dr. Harold Morrison of the Bureau of Entomology and Plant Quarantine as *Pseudococcus maritimus* (Ehrh.). Dr. Morrison stated, however, that the genus was in such an unsatisfactory state taxonomically that he does not make unqualified determinations.

but hatching continues through the first half of July. The newly hatched individuals soon leave the cottony masses and begin feeding on the twigs. Some of these reach the adult stage during August, and eggs that produce the over wintering brood were found as early as August 30. However, egg laying may continue until late fall and hatching continues from about September 15 until cold weather appears.

In December, 1944, a rather unusual condition was observed in that many eggs were found on the main stems of plants just below the surface of the soil. These were observed several times during the winter and spring and apparently none survived. No viable eggs were found during spring months. Whether deposited in the interior of the plant or under the surface of the soil, eggs that failed to hatch before cold weather appeared were shriveled and discolored in the spring.

Mealybug eggs on *Taxus* are frequently attacked by natural enemies. A predator and a parasite were reared in significant numbers from egg masses collected in nurseries of northern Ohio. These were respectively *Sympherobius amiculus* (Fitch), Family Hemerobiidae (determined by A. B. Gurney) and *Pseudleptomastix* sp., Family Encyrtidae (determined by A. B. Gahan). The three infested plants carried to Wooster in 1944 received no insecticidal treatment, but the mealybug population was attacked by natural enemies and by 1947 the infestation had disappeared. These plants are now growing normally although somewhat deformed.

CONTROL INVESTIGATIONS.—In 1944, field experiments in control of the grape mealybug on *Taxus* were carried on at Ghent and at Rossford. At Ghent, three applications were made at intervals of about 15 days beginning June 24. Many of the insects were in the egg stage and were deeply imbedded in dense masses of the cotton-like fibers when the sprays were applied. Consequently the spray materials all of which were contact insecticides, failed to come in contact with all of the insects.

Thiocyanate constituted the killing agent in four of the sprays tested and all the sprays reduced the population significantly although none resulted in commercial control. The fifth material contained a dinitro compound which proved less effective than thiocyanate.

The experiment at Rossford consisted of but one application which was made on August 8 when practically all of the mealy bugs were feeding on the foliage and consequently were more easily covered with insecticides. Five experimental treatments were employed and each was replicated five times. Thiocyanate again constituted the killing agent in four of the materials tested; the fifth was DDT. Counts made 3 weeks after the sprays were applied showed that 90 per cent of the plants sprayed with the most effective commercial thiocyanate preparation were free from mealybugs, and only an occasional individual could be found on infested plants. On the other hand, 70 per cent of the plants sprayed with DDT were infested and on a number of plants the infestation was severe.

Table 1.—Laboratory experiments in control of mealybug, 1945.

MATERIALS IN 100 GALLONS	PER CENT AVERAGE MORTALITY
1. Dormant oil (a),[1] 2 gallons	76.0
2. Dormant oil (b),[2] 2 gallons	75.8
3. Dormant oil (c),[3] 2 gallons	77.4
4. Sodium dinitro ortho cresylate,[4] 1 gallon	99.8
5. Thiocyanate,[5] 1 quart	100.0
6. Dinitro-o-cyclohexylphenol, dicyclohexylamine salt,[6] 1¼ pounds	52.6
7. Check (No treatment)	15.0

[1] *Orthol-D Soluble*, California Spray Chemical Company.
[2] *Kleenup Soluble*, California Spray Chemical Company.
[3] *Dendrol*, Standard Oil Company of Indiana.
[4] *Elgetol*, Standard Agricultural Chemicals, Inc.
[5] *Loro*, E. I. duPont de Nemours & Co.
[6] *DN-111*, Dow Chemical Company.

In March 1945, infested *Taxus browni* twigs were collected at Rossford and carried to Wooster for use in laboratory spraying experiments. The twigs were cut in lengths of 6 to 8 inches and five such twigs were included in each test. Six treatments and a check were included. The sprays were applied with an electric atomizer on March 26, after which the twigs were placed upright in moist sand. Three days later mortality counts were made under a binocular microscope. A total of 1533 mealybugs were counted, or an average of 219 on the five twigs that constituted a treatment. The data obtained are summarized in table 1.

Thiocyanate again proved the most ef-

fective of the materials used. The sodium dinitro ortho cresylate also proved very effective but it was considered unsafe for use on *Taxus* foliage. The three oils appeared to be approximately equal in effectiveness.

On April 17, a series of delayed dormant sprays were applied experimentally in the nursery at Rossford. A small power sprayer was used at a pressure of about 150 pounds. Seven treatments were employed and each was replicated five times. Each plot consisted of six plants in a single row. On June 28, when the mealybugs were well grown and could readily be found, counts were made by examining each plant and recording the number infested. A plant was recorded as infested if a single live mealybug could be found. The data are summarized in table 2.

Table 2.—Mealybug control experiments, Rossford, Ohio, 1945.

Materials in 100 Gallons	Per Cent Trees Infested
1. Thiocyanate, 1 quart Spreader-sticker,[1] 3 fluid ounces	32.9
2. Thiocyanate, 1.33 pints Spreader-sticker,[1] 3 fluid ounces	37.0
3. Dormant oil (a), 3 gallons	6.2
4. Dormant oil (b), 3 gallons	16.2
5. Dormant oil (c), 3 gallons	13.3
6. Dormant oil (a), 3 gallons 40% nicotine sulfate, 1 pint	4.0
7. 40% nicotine sulfate, 1 quart Spreader,[2] 3 ounces	73.8

[1] *Duponol*, E. I. du Pont de Nemours & Co.
[2] *Orvus*, Procter & Gamble Co., Cincinnati, Ohio.

The data presented in Table 2 seem contradictory to that in Table 1 in that the oils were more effective than thiocyanate in one case and less effective in the other. However, in the field experiment, many of the tiny mealybugs were well protected and consequently were not reached by the spray materials. The oils, however, had sufficient residual action to kill many of the insects as they emerged from hibernation. The taxus foliage appeared oily for several weeks following the application. All of the oils caused foliage injury that could be detected three month after the sprays were applied.

Early in the summer of 1948 a series of experiments were undertaken in a heavily infested planting of *Taxus brevifolia* at Perry, Ohio. Six treatments and a check were included and each was replicated 5 times on one-tree plots. Sprays were applied with a knap-sack sprayer and one dust was applied with a plunger type hand duster.

The first application was made on May 19. At that time the mealybugs were too small to be found readily with the unaided eye, but examinations with a binocular microscope indicated that practically all were located on the twigs where they were exposed to the action of contact insecticides. A second application was made on June 2. In both cases sprays were applied carefully and thoroughly to all parts of each plant.

Counts of living and dead mealybugs were made on May 27 and again on June 9 by taking twig samples from each tree and examining them under a binocular microscope. The data obtained are summarized in table 3.

Table 3.—Mealybug control experiments. Perry, Ohio, 1948. Treatments applied May 19 and June 2.

Materials in 100 Gallons	Per Cent Mortality	
	May 27	June 9
1. Thiocyanate, 1.66 pints Spreader-sticker,[1] 3 fluid ounces	94.2	98.8
2. Hexaethyl tetraphosphate (50%) 1.6 pints	60.4	54.5
3. Benzene hexachloride (25% gamma isomer) 0.75 pound	33.4	37.4
4. Chlordan (50%) 2 pounds	49.8	43.6
5. Parathion (25%) 1 pound	83.2	100.0
6. Chlorinated camphene—5% dust	50.6	33.0
7. Check (No treatment)	4.0	0.0

[1] DuPont Spreader-Sticker, E. I. du Pont de Nemours & Co.

The thiocyanate and the parathion treatments both resulted in excellent control. The entire block in which the experimental plots were located was sprayed with parathion on June 9 at the rate of 1 pound of a 25 per cent formulation in 100 gallons. A power sprayer was used at a pressure of approximately 200 pounds. Counts made from twig samples collected on June 16 showed 20 living and 159 dead mealybugs. The planting was then given a second application in the same manner. Three days later no living mealybugs could be found.

CONCLUSIONS.—Two generations of *Pseudococcus maritimus* (Ehrh.) occur annually on *Taxus* in Ohio. Eggs are deposited during the latter half of June and again during September and October in

large masses of white fibrous material. This material is sufficiently dense that the insects are protected from the action of most contact insecticides until the eggs hatch and the young emerge from the fibrous material.

The results of four series of field experiments indicate that the optimum time for the application of sprays for the control of mealybug on *Taxus* occurs during the latter half of May and the first half of June. Sprays were relatively ineffective during late June and early July, but again became more effective during August.

Under Ohio conditions, both parathion and thiocyanate have produced excellent results in the control of the grape mealybug on *Taxus* when used in two applications at 10-day intervals beginning during the latter half of May or early in June.

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Susceptibility of Winter Eggs of the European Red Mite to Petroleum Oils and Dinitro Compounds[1]

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A control measure for European red mite commonly employed by New York apple and plum growers is the use of a treatment to destroy the winter eggs. Heretofore, a petroleum oil spray has been used almost exclusively for this purpose. Other materials are now showing promise as mite ovicides, notably one or more dinitro compounds.

There were two main objectives in the present study: (1) to determine the efficiency of two classes of dinitro products used alone and in combination with oil, and (2) to determine the efficiency of oil treatments applied at various intervals before hatching. Dean (1943) has published some data on the latter subject. He obtained poorest results with oil sprays applied in the full dormant period, best results from treatments made in the "delayed dormant"[2] bud stage, while sprays applied in the "green-tip" stage were intermediate in their efficiency. This subject has been explored further and in some detail in the present study.

METHODS.—The experiments described here were conducted under orchard conditions. A block of mature Wealthy apple trees was used for the principal part of the work, but results are also included on tests carried out in a planting of Elberta peaches on the same farm. Standard orchard spraying equipment was used to apply the treatments. Usually the plots consisted of two trees each in the apple block and from 8 to 10 trees when peach trees were involved.

Efficiency ratings for the various treatments are based on the hatching rate of mite eggs in samples of spurs or twig sections taken at random from each plot. The technique used has been described by Chapman & Avens (1948, pp. 192–3). Aphid eggs were involved in the paper cited but the equipment used and the handling and other procedures followed were essentially the same for mite and aphid eggs. Briefly this is the method: A number of small branches are cut at random from test trees following treatment. Spurs and twigs of this sample judged to bear a suitable egg population are next cut into 1 to 3 inch lengths. A count is then made under a binocular microscope of the number of plump, fully-colored and thus presumably healthy eggs present on individual wood sections. (There is no indication that treatment with oil or dinitro products appreciably alters the normal appearance of the eggs.) Counted twigs sections are impaled on brads which are anchored in a square of plywood. Each such impaling block accommodates 12

[1] Journal paper No. 784, New York State Agricultural Experiment Station, Geneva, New York. November 24, 1948.
[2] When leaves in apple blossom buds are exposed 0.25 to 0.5 inch.

sections bearing a total, ideally, of between 750 and 1000 eggs. The blocks are held under outdoor conditions until near egg hatching time when the block is ringed with a sticky barrier to entrap any mites hatching from eggs that survived the treatment.

MATERIALS.—A single oil was used throughout and its specifications are given in table 1. The current specifications established at this Station for a "superior-type" spray oil for use in the dormant and semi-dormant periods are also included in this table. It will be noted that the oil used in the present study meets the standards for a superior-type oil.

The lots of oil spray were prepared by the tank mixing procedure using blood albumin as the emulsifying agent at the rate of 2 ounces (actual) per 100 gallons of finished spray. The standard procedure used in New York for preparing spray oil emulsions by tank mixing is as follows:

Table 1.—Specifications of spray oils.[1]

PROPERTIES	OIL USED IN TESTS	"SUPERIOR TYPE DORMANT OIL"
Viscosity (Saybolt, at 100°F.)	103.9	90–120
Viscosity Index (Kinematic)	96	90 (minimum)
Gravity (A.P.I. degrees)	32.5	31 (minimum)
Unsulfonated Residue (A.S.T.M.)	92	90 (minimum)
Pour Point, °F.	25	30 (maximum)
Homogeneity	A relatively narrow boiling distillate portion of petroleum.	

[1] The following methods of testing are employed:
Viscosity: Kinematic, A.S.T.M. Designation: D 445–39 T, Conversion to Saybolt Universal Viscosity, A.S.T.M. Designation D 446–39.
Kinematic Viscosity Index: A.S.T.M. Designation: D 567–40 T
A.P.I. Gravity: A.S.T.M. Designation: D 287–39
Pour Point: A.S.T.M. Designation: D 97–39
Unsulfonated Residue: A.S.T.M. Designation: D 483–40

Table 2.—Susceptibility of winter eggs of the European red mite to "superior-type" petroleum oil sprays applied at various intervals preceding hatching, 1948.

APPLICATION TIME										
Date	Apple Bud Stage	Day Before Start of Hatching	Oil Conc. in Spray Per Cent	Host	No. Twig Samples	Total No. Eggs	Ave. Per Cent Hatch		Standard Error	Per Cent Control Eff.
March										
18	dormant	39	0.25	apple	5	2986	35.2	±	1.4	34.0
			0.50	"	5	3033	28.8	±	2.5	46.0
			1.00	"	5	2631	18.3	±	2.6	65.7
			2.00	"	5	3422	12.6	±	2.9	76.4
			3.00	"	5	3920	4.5	±	0.7	91.6
April										
5	silver tip	21	.25	peach	5	6776	17.2	±	2.4	75.5
			0.50	"	5	5675	16.9	±	1.9	75.9
			1.00	"	5	4837	11.5	±	0.9	83.6
			2.00	"	5	5194	5.3	±	0.8	92.4
			3.00	"	5	4724	1.3	±	0.9	98.1
10	green tip	16	0.25	apple	5	4160	18.0	±	1.3	66.2
			0.50	"	5	4473	6.9	±	1.0	87.1
			1.00	"	5	4837	3.3	±	1.0	93.8
			2.00	"	5	4400	1.4	±	0.5	97.4
			3.00	"	5	3957	0.6	±	0.2	98.9
20	delayed dormant	6	0.125	"	5	4352	21.0	±	2.4	60.6
			0.25	"	5	4625	11.3	±	0.8	78.8
			0.50	"	5	4564	10.5	±	0.8	80.3
			1.00	"	5	3937	1.9	±	0.3	96.4
			2.00	"	5	4131	1.5	±	0.2	97.2
			3.00	"	5	3955	0.3	±	0.2	99.4
26	pre-pink	0	0.125	peach	3	2761	13.3	±	2.2	81.0
			0.25	"	3	3379	6.9	±	0.9	90.2
			0.50	"	3	3466	1.8	±	0.7	97.4
			1.00	"	3	2843	0.6	±	0.1	99.1
			2.00	"	3	2002	0.2	±	0.1	99.7
			Control	apple	22	18,046	53.3	±	2.4	—
			Control	peach	13	12,916	70.1	±	2.1	—

With the engine running 20 to 25 gallons of water are drawn into the spray tank. Next, the emulsifier is added, then the oil. The spray-gun is now directed into the spray tank and opened for 1 to 1.5 minutes. Effective emulsification is obtained by this circulation of oil, water and emulsifier through the pump and back into the tank through the spray gun. The final operations are to fill the tank with water and clear the hose-line of concentrated emulsion, preferably returning it to the tank.

The two dinitro products tested, were:

1. A slurry containing 22 per cent sodium dinitro-o-cresylate.[1]

2. A liquid formulation containing 36 per cent of the triethanolamine salt of dinitro-o-secondary butyl phenol.[2]

RESULTS AND DISCUSSION.—The data obtained on the oil sprays applied at various intervals preceding the hatching period are given in table 2 and figure 1. As will be seen the records obtained in the apple and peach blocks have been combined. Originally it was planned to compare the efficiency of oil sprays applied at only three bud stages on apple. When it was found that the data from peach fit rather precisely into the general pattern established by the apple data it was deemed permissable to combine the records. Whether or not one accepts this action is immaterial for the data trends are evident, based either on the apple or combined data. The obvious advantage in combination is that data are available on egg susceptibility at five rather than at three intervals preceding hatching. The only way the authors believe the host may possibly play some part in the action of oil sprays is in varying oil deposition rate occasioned by differences in bark surface. Data trends in the present instance suggest this is a minor factor.

Results of tests conducted with dinitro compounds used alone and combined with oil are given in table 3. These sprays were applied March 24 to apple trees when the buds were still fully dormant.

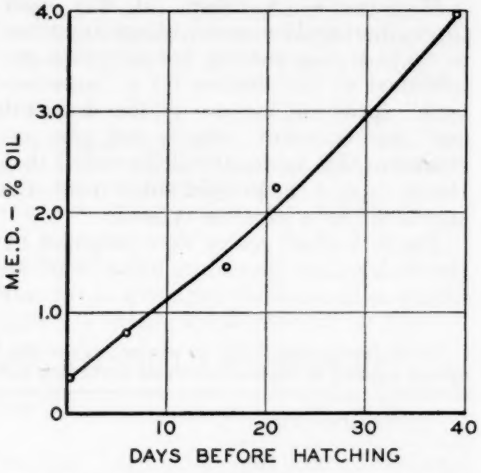

FIG. 1.—Graphic analysis of data given in table 1. The minimum effective dosage (M.E.D.) for each application date has been determined from dosage-mortality curves. The point of 95 per cent kill or LD95 has been used for the M.E.D.

It is evident the from data in table 2 that the overwintering eggs of the European red mite vary considerably in susceptibility to spring applied oil sprays. Within the period covered by the experiment—and this spanned the period it was

[1] *Elgetol*, Standard Agricultural Chemical Co.
[2] DN289, Dow Chemical Co.

Table 3.—Efficiency of dinitro compounds used alone and in combination with petroleum oil against winter eggs of the European red mite on apple, 1948.

TREATMENT	TWIG SAMPLES	TOTAL EGGS	AVE. HATCH		STANDARD ERROR	CONTROL EFF.
			Per Cent			*Per Cent*
Dinitro-o-secondary butyl phenol						
0.25%	5	3960	16.9	±	1.4	68.3
0.5 %	5	5003	1.5	±	0.2	97.2
0.25% plus, 0.25% oil	5	4858	5.5	±	0.4	89.7
0.25% plus, 0.5 % oil	5	3678	7.0	±	0.9	86.9
0.25% plus, 1.0 % oil	5	4515	3.8	±	0.6	92.9
Dinitro-o-cresol						
0.5 % plus, 1.0 % oil	5	4343	44.5	±	4.2	16.5
0.5 % plus, 1.0 % oil	5	4469	9.7	±	1.7	81.8
Control	22	18046	53.3	±	2.4	

It is evident the from data in table 2 that the overwintering eggs of the European red mite vary considerably in susceptibility to spring applied oil sprays. Within the period covered by the experiment—and this spanned the period it was

possible practically to apply such sprays in 1948—egg susceptibility increased progressively as the hatching period was approached. Thus a 0.25 per cent oil spray applied at the beginning of hatch (April 26) gave essentially the same degree of control as a 3 per cent strength applied 39 days earlier. This clearly illustrates the advisability of delaying oil sprays for mite control as late as possible. Whether or not it would be feasible in this area to apply this treatment to trees in the pre-pink stage (April 26) is uncertain owing to possible complications with sulfur fungicides. Such a practice is little followed in New York at present. Many local growers are using oil sprays in the green-tip and delayed dormant bud stages. At these periods a 2 per cent concentration of a superior oil has proved relatively safe to the trees and highly effective in killing mite eggs.

The present experiments confirm another finding of Dean (1943) on oil applications made in the full dormant period. Mite eggs appear to be relatively resistant at this time. In the present tests a 3 per cent strength gave an efficiency of only 91.6 per cent. To derive much benefit in control, a kill of at least 97 per cent of the overwintering eggs is considered necessary. Dean failed to obtain this control level even at 4 per cent concentrations. From almost every standpoint—economy, tree safety and poor results in mite control—the use of oils to combat this pest in the full dormant period seems inadvisable.

From the data shown in table 3 it is seen that the dinitro-o-cresol proved virtually worthless. The triethanolamine salt of dinitro-o-secondary butyl phenol however, proved quite effective at the higher concentration tested. The fact that this latter material gives promise of being a satisfactory mite ovicide and shares with dinitro-o-cresol a high potency in killing aphid eggs and hibernating larvae of the eye-spotted bud moth, commends it for serious consideration as a general purpose dormant treatment for apples in New York. It is a highly caustic material and until experience may show otherwise, its use should be limited to the spring and to truly dormant treatment.

Some interest has been shown in combining small amounts of oil with relatively low concentrations of dinitro compounds, with the object of each supplementing the action of the other. As will be seen, control efficiency was increased over what was obtained with the dinitro product alone. It still was not raised sufficiently to warrant the practice, judged by the present data.

SUMMARY.—Oil sprays prepared from a a single product were compared for their ovicidal efficiency against winter eggs of the European red mite when applied at the beginning of the hatching period and at 6, 16, 21 and 39 days preceding this event. Susceptibility of the eggs increased as the interval between spraying time and hatching was reduced. An efficiency of only 91.6 per cent was obtained with a 3.0 per cent oil spray applied 39 days before hatching or in the full dormant period. Essentially this same kill, 90.2 per cent, was realized with only 0.25 per cent oil in a spray applied at the beginning of hatch. A product containing dinitro-o-cresol as the chief toxic agent proved ineffective. At a 0.5 per cent concentration, a formulation containing 36 per cent of the triethanolamine salt of dinitro-o-secondary butyl phenol, gave 97. 2 per cent control. This is about the same control as was obtained with a 2 per cent oil spray applied in the green-tip and delayed dormant period or 6 and 16 days before hatching in 1948.[1]

[1] Acknowledgement: The writers wish to express their appreciation to the Shell Oil Company for a grant-in-aid which has covered part of the cost of this study.

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Control of the Fig Scale in California

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The fig scale, *Lepidosaphes ficus* (Sign.), is presumed to have been brought into California about 1905, but apparently no extensive control studies were made until 1917. In that year F. P. Roullard (1917) published a description of the life history of the scale and suggested dormant sprays for its control. During the same year R. L. Nougaret, United States Bureau of Entomology, began control studies. The work of Nougaret in 1917–18, of A. J. Flebut in 1922, and of E. A. McGregor in 1925 and 1927 was summarized by Simmons *et al.* (1931) with the statement that, "the only materials that have given promise of controlling the insect are oil emulsions and combinations of lime-sulfur and oil."

In 1938, C. Kinsley[1] reviewed the fig-scale situation in Merced County and reported good control without tree injury following the use of 6 per cent oil of 135 to 142 seconds Saybolt viscosity and 70 per cent unsulfonatable residue applied in February. The necessity of good coverage was emphasized.

By 1943 the fig scale had become widespread and many of the infestations were heavy. Since little organized effort to study control had been made previously, investigations were begun by the writers in December 1943 to determine necessary concentrations of dormant oil and proper timing of application. Plans were also made to investigate the possibility of control in the spring and to determine the effectiveness of other insecticides.

ECONOMIC IMPORTANCE.—The scales that settle on the fruit cause the greatest losses. On Kadota figs that are intended for canning, the part beneath and surrounding the scale remains dark green through the processing. Figs with three or more such spots must go into jam stock, with consequent reductions in returns. In 1945 and 1946 canning stock brought $125.00 a ton, whereas jam stock was paid for at the rate of only $30.00 a ton in 1945 and $40.00 in 1946. On the basis of a crop of 5 tons per acre, the percentages of figs showing more than three scale marks indicate that the loss in the unsprayed plots of 1945 was at the rate of $216.60 per acre. Losses where dormant oils or summer oils were used were at the rate of $30.40 to $33.72 per acre. The figures secured in 1946, a year of lighter infestation, were considerably less. The loss in the unsprayed plots that year was estimated at $24.33 per acre.

Heavily infested drying figs are less acceptable to packers, being lighter in weight and having a warty appearance. The influence of fig scale control on the quality of Adriatic figs is illustrated in figure 1. The figs from the untreated trees

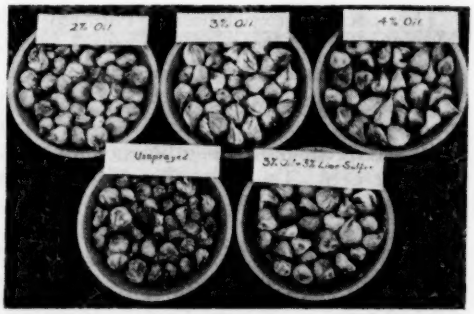

FIG. 1.—Adriatic figs from sprayed and unsprayed trees. The improvement in quality following the use of 3 per cent and 4 per cent dormant oil sprays is shown by the three samples at the right.

were small, shriveled, spotted from scale attack, and light in weight—the type of figs avoided by buyers. The figs from the trees treated with 3 or 4 per cent oil sprays were large, heavy, thin skinned, and possessed the characteristics desired in good-quality fruit.

LIFE HISTORY.—Adult fertilized females pass the winter on the trees. Although live scales may be found on any succulent bark on the trees, most of them are on the wood of the last 2 years.

The scales, particularly those on the trunks, may begin to lay eggs in February. It is mid-March before egg laying becomes general. By that time the leaves of the Adriatic variety of fig are 0.5 to 0.75 inch in length. The overwintered females lay about 30 eggs each.

[1] Paper read at annual meeting of the California Fig Institute, Fresno, Calif., January 19, 1938.

Table 1.—Control of fig scale on Adriatic figs with dormant oil spray in 1944 and 1945 as measured by mortality of overwintering scales, scales established on the leaves in mid-June, and percentage of infected figs at harvest time.

TREATMENT[1] (OIL GALLONS PER 100 GAL.)	DATES OF APPLICATION[2]	PER CENT MORTALITY OF OVER-WINTERING SCALES[3]	AVERAGE NUMBER OF SCALES ON LEAVES AT END OF SPRING BROOD[4]	PER CENT INFESTED FIGS[5]
	(1944)			
2 gal.	Jan. 3	68.8	243	92
	Jan. 12	71.7	262	99
	Feb. 11	70.9	190	88
	Mar. 10	72.7	48	64
	Average	71.0	186	86
3 gal.	Jan. 3	99.6	45	48
	Jan. 12	99.6	63	66
	Feb. 11	98.7	10	43
	Mar. 10	97.3	5	26
	Average	98.8	33	46
4 gal.	Jan. 3	100.0	3	12
	Jan. 12	96.9	4	44
	Feb. 11	99.8	6	29
	Mar. 10	99.9	1	9
	Average	99.2	6	23
3 gal.+liquid lime-sulfur 3 gal.	Jan. 3	98.9	29	36
	Jan. 12	92.9	49	72
	Feb. 11	100.0	3	22
	Mar. 10	100.0	3	17
	Average	98.0	21	36
Unsprayed checks	Jan. 3	5.0	1208	100
	Jan. 12	3.6	685	100
	Feb. 11	6.3	1199	96
	Mar. 10	5.2	1153	99
	Average	5.0	1061	99
	(1945)			
2 gal.	Feb. 15	—	51	78
3 gal.	Feb. 15	—	4	46
4 gal.	Feb. 15	—	3	25
Unsprayed check	Feb. 15	—	148	98

[1] Blood albumin used at rate of 4 oz. per 100 gal.
[2] Two plots sprayed with each material on each date in 1944 and 5 in 1945.
[3] Observations made about a month after treatment: 1800 scales examined from each treatment on each date.
[4] Observations made in mid-June; 12 leaves examined from each treatment on each data in 1944 and 60 in 1945.
[5] Observations made at harvest time; 500 figs examined from each treatment on each date in 1944 and 1500 in 1945.

Hatching of the spring brood of eggs begins about the first of April. The young crawlers from these eggs settle on the foliage. Egg laying and hatching continue so that crawlers from the overwintered females are present until late June.

The summer, or leaf- and fruit-infesting, form of this scale was formerly considered to be *Lepidosaphes ficifoliae* (Berlese). V. Lupo (1945) found that this form was the progeny of *L. ficus*, which had overwintered on the wood and was not a separate species. The writers verified this in 1946.

The females on the leaves are smaller than those on the wood, and their scale covers are less regular in shape. They lay about 12 eggs each. Eggs of the earliest females in this brood begin hatching from June 15 to 20. It follows that crawlers from both the overwintered females and females which developed on the foliage are present on the leaves during the latter part of June. Males are found almost exclusively on the leaves.

After mid-summer many of the female crawlers establish themselves on the wood. During August the scales on the wood

increase rapidly in abundance. Mating of the overwintering females takes place in the fall.

METHODS.—On the basis of the utilization of the crop and the consequent differences in cultural practices, figs many be divided into two classes, drying and canning. Most of the control studies were made on Adriatic fig trees, representing the drying varieties, and on Kadota fig trees, the fruit of which is used for canning. The Adriatic plots, located in Fresno County, were in rows of trees bordering other crops and in most tests consisted of 3 trees each. The center trees were designated as count trees, and samples to determine the effectiveness of the treatments were taken from these trees. The plots were arranged to obtain the greatest possible uniformity of size among all count trees. The Kadota plots were located in a Merced County orchard. In 1944 and 1945 they consisted of 9 trees each, 3 on a side, the center tree being designated as the count tree. In 1946 the Kadota plots contained 16 trees, 4 on a side, with the 4 center trees being designated as count trees.

From 13 to 15 gallons of dilute spray per tree were required to spray thoroughly the dormant Adriatic fig trees. The smaller

Table 2.—Control of fig scale on Kadota figs with dormant oil spray in 1944, 1945, and 1946 as measured by mortality of overwintering scales and percentage of infested figs at harvest time.

TREATMENT[1] (OIL, GALLONS PER 100 GAL.)	DATES OF APPLICATION[2]	MORTALITY OF OVERWINTERING SCALES[3]		CONDITION OF SAMPLES OF FIGS	
		Number Examined	Per Cent Dead	Number Examined	Per Cent Infested
2 gal.	12-31-43	267	52.2	1313	9.8
	1-14-44	279	60.0	748	4.6
	2-11-44	400	56.2	1486	8.9
	3- 8-44	700	97.0	1193	3.7
Totals and averages		1646	83.7	4740	7.1
3 gal.	12-31-43	372	94.2	944	1.3
	1-14-44	231	100.0	1034	2.3
	2-11-44	400	98.0	1114	1.1
	3- 8-44	370	99.7	1248	.8
Totals and averages		1343	97.8	4340	1.3
4 gal.	12-31-43	357	100.0	1132	1.1
	1-14-44	252	100.0	1176	.9
	2-11-44	253	100.0	990	1.3
	3- 8-44	356	100.0	802	.1
Totals and averages		1218	100.0	4100	.9
3 gal.+liquid lime-sulfur 3 gal.	12-31-43	189	100.0	1103	.7
	1-14-44	229	100.0	1042	1.2
	2-11-44	400	99.5	857	2.1
	3- 8-44	400	100.0	613	.0
Totals and averages		1218	99.8	3615	1.1
Unsprayed checks	12-31-43	48	18.5	762	11.8
	1-14-44	242	9.5	1335	37.9
	2-11-44	309	15.9	1189	34.9
	3- 8-44	285	3.5	1228	36.6
Totals and averages		884	10.3	4515	32.1
4 gal.	2-17-45	—	—	3139	26.3
Unsprayed checks	2-17-45	—	—	3147	72.6
3.5 gal.	2- 5-46	—	—	8338	10.2
Unsprayed checks	2- 5-46	—	—	8249	26.9

[1] Blood albumin was used at the rate of 4 oz. per 100 gal.
[2] Two plots were sprayed with each material on each date in 1944, 3 in 1945, and 4 in 1946.
[3] Observations were made about a month after treatment; scales were examined from each plot for each treatment on each date.

Kadota trees, which were 6 to 7 feet in height after winter pruning, required from 3 to 6 gallons for thorough coverage. The sprays were applied with standard makes of orchard spraying equipment operating at 500 to 600 pounds pressure.

Three methods were used extensively to measure the effectiveness of the spray treatments. The mortality of adult female scales on the wood was determined about a month after treatment. A sample from the Adriatic fig trees consisted of a uniform number of twigs from each plot in an experiment, the number being usually 12, but sometimes 6 per count tree depending on the number of scales to be examined. The twigs were selected so that as many different parts of the tree as possible were represented. The lighter infestation on the Kadota trees did not lend itself to the sampling system used for the Adriatic trees. Instead, infested bark flakes and twigs were taken from the trees wherever convenient, and an effort was made to examine at least 100 female scales from each plot.

The second method of measurement was to determine the number of first-brood scales established on sample leaves in mid-June. At that time there is a period of overlapping in which there are present on the leaves a maximum number of progeny of overwintered females and few of the subsequent brood. The differences in the number of scales established on the leaves indicated variations in the number of scales which had survived the several winter treatments. A sample consisted of a uniform number of leaves, 12 or 6 per count tree, so selected that different parts of the tree were represented in the sample. The third leaf on wood of the current season was taken for samples on Adriatic trees and the first leaf on Kadota trees. Both immature and mature male and female scales, whether alive or dead, were counted on both upper and lower surfaces of each leaf.

The third and most important measure of effectiveness of the spray treatments was the amount of infested fruit at harvest. Normally, Adriatic figs are allowed to ripen on the tree and fall to the ground. They are picked up three or four times during the harvest season. In the experiments reported here the figs were picked up three times in the Adriatic plots at intervals of about 10 days, beginning early in September. Samples of 100 figs were taken beneath each count tree. In 1944, at the first two pickings, samples of 100 figs were examined, or all the fruit if the number gathered was less than 100. At the third picking enough figs, gathered at random, were examined to round out the counts for each tree to a total of 250 figs.

During the first part of the Kadota harvest, figs from the count trees were examined twice a week. The schedule conformed closely to the usual practice of picking every 3 days. In 1944 and 1945 a sample of 100 figs was examined if more than 100 were taken from a tree, or all the figs if the number was less than 100. In 1946, 50 figs were examined from each of the four count trees, or all the figs if the number was less than 50. When the amount of infestation on fruit from the untreated trees showed a definite downward trend, the examinations were discontinued. The biweekly examination periods extended from August 29 through September 26 in 1944, from August 21 through September 28 in 1945, and from August 16 through September 20 in 1946.

MATERIALS.—The value of oil sprays, ovicides, and certain new insecticides in controlling the fig scale was tested during the investigation. The materials used were as follows:

Dormant winter oil; viscosity 100–103 seconds Saybolt, unsulfonatable residue 70 to 73 per cent.

Light summer oil; viscosity 62 seconds Saybolt, unsulfonatable residue 92 per cent.

Light-medium summer oil; viscosity 68 seconds Saybolt, unsulfonatable residue 92 per cent.

A proprietary material[1] containing 20 per cent of the sodium derivative of dinitro-ortho-cresol, with a wetting agent.

A proprietary material containing 30 per cent of the sodium derivative of dinitro-ortho-cresol, without a wetting agent.

Light summer oil with cube root (4.3 per cent rotenone content) and a proprietary material containing methyl naphthalene.[2]

Light summer oil with wettable sulfur and glycerol dioleate.

DDT dissolved in kerosene and the methyl naphthaline compound.[2]

[1] *Elgetol.*
[2] *Velsicol AR-60.*

Parathion, a new organic phosphate compound (a 20 per cent solution in the di-2-ethylhexyl ester of phthalic acid).

Blood albumin was used in sprays containing oils at the rate of 4 ounces per 100 gallons of dilute spray.

RESULTS WITH DORMANT SPRAYS.—*Mortality of adult female scales on twigs.* The susceptibility to dormant spray treatments of adult female scales on the twigs did not appear to vary between January 1 and March 10, as shown in tables 1 and 2, although high mortality was recorded when 2 gallons of dormant oil per 100 gallons was applied to Kadota figs on March 8. In general, 2 gallons of dormant spray oil per 100 gallons of water (2 per cent oil) gave unsatisfactory results. The 3 per cent oil, 4 per cent oil, and 3 per cent oil plus 3 per cent lime-sulfur sprays gave satisfactory control. Of the 16 plots treated with 4 per cent oil, all but one showed over 99 per cent mortality; the exception, 96.9 per cent mortality, was obviously due to poorer spray coverage.

The 3 per cent oil plus 3 per cent lime-sulfur gave about as satisfactory results as the 4 per cent oil spray, but the cost of materials was increased. In addition to the increased cost, lime-sulfur sprays were more disagreeable for the operator to handle than were oils alone.

In all but two treatments of plots used to compare the effects of oils, oils plus ovicides, or ovicides alone (Table 3), the kill of overwintered scales was excellent. The use of the ovicide sodium derivative of dinitro-ortho-cresol increased the cost of materials without increasing the control secured with oil alone. In the two treatments where the mortality was less than 98 per cent, equivalent amounts of the sodium derivative of dinitro-ortho-cresol were used. Where the mortality was 96.8 per cent the proprietary material contained a wetting agent, and in the plot where mortality was 90 per cent there was no wetting agent in the spray. Mortality following the use, on March 8, 1945, of 1 gallon of the ovicide with a wetting agent was only 15.5 per cent instead of 96.8 per cent as in 1944. Possibly the 1945 applications were applied too early to be effective.

Survival of eggs. On March 10, 1944, over half of the female fig scales were laying eggs. In April, scales sampled from plots treated on March 8 were found to contain many hatched eggs under covers where the females had been killed. In the Adriatic plots between 3 and 23 per cent of the dead females were associated with hatched eggs and in the Kadota plots between 30 and 43 per cent. In some tests it was found that all the eggs under a scale had hatched or were about to hatch; in others only a portion had hatched; and in a few cases all the eggs had been killed. Although no records were taken, it appeared that survival increased with an increase in the number of eggs present. Either not enough oil was applied to kill the females and cover all the eggs, or the females laid a number of viable eggs before succumbing to the oil.

When the sprays that were put on to compare the effect of oil, oil plus ovicide, and ovicide alone were applied on March 17, 1944, more than 85 per cent of the scales on the Adriatic trees were ovipositing. The contrasts in results when sprays with and without ovicides were used (Table 3) were obvious and indicated high egg mortality when the sodium derivative of dinitro-ortho-cresol was used.

Table 3.—Apparent effect of ovicides on control of fig scale on Adriatic fig trees 1 month after treatment on March 17, 1944, as measured by mortality of over-wintering scales and dead females with hatched eggs under the scale covers.

TREATMENT[1] (PER 100 GAL.)	PER CENT MORTALITY[2]	DEAD FEMALES WITH HATCHED EGGS	
		Number Examined	Per Cent
Dormant oil:			
2 gal.	99.7	598	51.7
3 gal.	100.0	600	41.7
4 gal.	100.0	600	20.0
3 gal.+liquid lime-sulfur 3 gal.	100.0	600	33.7
2 qt.+20% di-nitro 1.5 gal.[3]	99.8	599	0
2 qt.+30% di-nitro 1 gal.[4]	100.0	600	.2
1 gal.+20% di-nitro 0.75 gal.	100.0	600	.8
1 gal.+30% di-nitro 0.5 gal.	98.3	590	.2
2 gal.+20% di-nitro 0.75 gal.	99.8	599	0
2 gal.+30% di-nitro 0.5 gal.	99.8	598	0
3 gal.+20% di-nitro 0.75 gal.	100.0	600	.2
3 gal.+30% di-nitro 0.5 gal.	99.7	598	.2
20% di-nitro 1 gal.	96.8	581	2.1
30% di-nitro 0.66 gal.	90	543	1.8
20% di-nitro 2 gal.	99.8	599	0
30% di-nitro 1.33 gal.	99.8	599	.2
20% di-nitro 4 gal.	100.0	600	0
30% di-nitro 2.66 gal.	100.0	600	0
Unsprayed check	3.2	—	—[5]

[1] Blood albumin used at rate of 4 oz. per 100 gal. if sprays contained oil.

[2] 600 scales from each plot were examined.

[3] A sodium derivative of dinitro-ortho-cresol and a wetting agent (*Elgetol*).

[4] A sodium derivative of dinitro-ortho-cresol and no wetting agent (*Elgetol 30*).

[5] More than 85% of the females were laying eggs when the trees were sprayed and hatch was 20% complete when the observations were made.

First brood on the foliage. In general, when the effectiveness of the treatments was measured by the number of first-brood scales on the foliage in mid-June and by the mortality of overwintered scales, the results were comparable. Furthermore, on very heavily infested twigs the number of scales on the foliage was large, an indication that the heavier the infestation the larger the number of individuals which survived, even where percentages of kill had been high.

Both the initial scale infestations on the dormant wood and the concentration of oil in the dormant sprays were found to be important factors in control. Table 4 shows that reduction in progeny followed use of increased amounts of oil, and that there was a tendency for more individuals to survive a given treatment if the initial infestation was heavy. The samples were taken on June 21, 1944, from the northeast side of Adriatic trees which had been sprayed with 2, 3, and 4 per cent oil during the preceding winter.

Table 4.—Influence of initial fig scale infestation during period fig trees were dormant, and influence of concentration of oil in dormant sprays on progeny subsequently settling on the leaves.

Treatment (Oil, gallons per 100 gal.)	Overwintered Scales on 1943 Wood		Resulting First-Brood Scales on 1944 Leaves	Progeny per 1000 Overwintered Scales
	Total	Per Inch		
2	591	74	10099	17088
	357	51	1492	4179
	87	16	382	4391
3	792	132	346	437
	515	74	83	161
	308	56	64	208
4	408	82	16	39
	222	37	3	14
	275	50	1	4

There were fewer first-brood scales on the foliage of the Adriatic trees which were treated on March 10 than on those treated earlier in the winter with the same concentration of oil. This is shown in table 1. Foliage infestation following treatment with 4 per cent oil on March 17 was also low even though, a month after treatment, there were hatched eggs under 20 per cent of the scales containing dead females. It is possible enough oil remained from the late treatments to prevent establishment of many crawlers.

Infestation on fruit. As might be expected from the data on kills of overwintering female scales and on the number of first-brood scales on the Adriatic foliage in mid-June, the order of effectiveness of dormant sprays in reducing the amount of infested fruit was: first, 4 per cent oil; second, 3 per cent oil and 3 per cent lime-sulfur; third, 3 per cent oil; and last, 2 per cent oil. The comparisons appear in tables 1 and 2. Also, the better control of scale on the foliage from dormant oil sprays applied in March rather than earlier in the year was noted again when the fruit was examined for scale infestation. The dormant oils applied in February of 1945 and 1946 did not give as good control as expected. The poorer control, in the 1945 plots at least, was the result of poor spray coverage.

RESULTS WITH SPRING SPRAYS.—In mid-May of 1945 and 1946, sprays containing light summer oils were applied to Kadota fig trees. The eggs of the overwintered females were hatching, the crawlers were establishing themselves, and none of the summer brood was mature when the trees were sprayed. As shown in table 5, there were only small differences between the infestations on figs from trees treated with the light oils in May and on fruit from trees treated with dormant oils in February. Two of the sprays caused foliage injury. In 1945 the spray containing light summer oil and wettable sulfur caused moderate leaf burn. The spray with 3 gallons of a kerosene solution containing 8 per cent DDT and 20 per cent of a methyl naphthalene compound[1] to 100 gallons of water caused severe defoliation in 1946. To what extent this injurious effect might be lessened by reducing the methyl naphthalenes is not known. The percentages of infested fruit from the trees treated with DDT were low.

A preliminary test of parathion for control of the fig scale was eucouraging. On March 31, 1947, a spray consisting of a pint of a solution containing 20 per cent parathion in di-2-ethylhexyl ester of phthalic acid to 100 gallons of water was applied to an Adriatic fig tree. The hatching eggs of the overwintered females was about to begin at that time. Normally adults are numerous early in July but, in contrast to the untreated trees, observations at the time showed only immature scales on the sprayed tree. The eggs or

[1] *Velsicol AR-60.*

Table 5.—Comparison of dormant and late spring sprays for control of fig scale on Kadota fig trees as measured by the average number of scales per leaf in mid-June and the percentage of infested figs at harvest time.

Treatment (per 100 Gal.)[1]	Dates of Application[2]	Average Number of Scales of Leaves at End of Spring Brood[3]	Examination of Figs at Harvest Time		
			Number Examined	Per Cent Infested	Per Cent With More Than Three Scale Marks
	(1945)				
Light summer oil:					
2 gal.	May 17	5.6	3106	29.1	7.1
2 gal.+6 oz. cube root	May 17	10.1	2752	29.8	7.0
2 gal.+6 oz. cube root+1.5 oz. Methyl naphthalene comp.[4]	May 17	2.9	2955	34.7	9.5
1.5 gal.+4 lb. wettable sulfur+56 ml. glycerol dioleate	May 17	4.0	3309	38.9	11.2
Light-medium summer oil 2 gal.	May 17	2.6	2850	27.6	6.6
Dormant oil 4 gal.	Feb. 17	15.5	3139	26.3	6.4
Unsprayed checks	—	104.8	3147	72.6	45.6
	(1946)				
Light summer oil 2 gal.	May 13	—	7418	8.9	1.0
3 gal. of solution containing 8% DDT and 20% Methyl naphthalene comp.[4]	May 13	—	6579	5.2	0.6
Dormant oil 3.5 gal.	Feb. 5	15.5	8338	10.2	1.8
Unsprayed checks	—	—	8249	26.9	5.7

[1] Blood albumin used at rate of 4 oz. per 100 gal.
[2] Three plots sprayed with each material on each date in 1945 and 4 in 1946.
[3] Observations made in mid-June; 36 leaves examined from each treatment in 1945 and 1946.
[4] *Velsicol-AR60.*

the crawlers which had been produced during the earlier part of the brood apparently had been killed, but some of the later ones had survived.

SUMMARY.—The fig scale, *Lepidosaphes ficus* (Sign.), a pest of both drying and canning figs, was established in Fresno County by 1917, when the life history was described and control measures suggested by Roullard (1917). At the time the studies reported herein were begun, in 1943, most of the fig growing sections in northern California were infested, and the use of dormant oil sprays had replaced earlier spray materials.

During the years of depression, when the value of figs was low, there was little effort to control the insect except on figs grown for canning. As prices rose after the beginning of the late war, the interest in controlling the scale increased. Field practices, however, were not uniform.

The work of the writers was directed chiefly toward standardizing the concentrations and timing of dormant sprays. The possibility of control in the spring with summer oil sprays or other insecticides also was investigated. Studies in the field biology of the scale were made to provide a foundation for the work.

The scales that settle on the fruit cause the greatest losses. On canning figs the part beneath and surrounding the scale remains dark green through the processing. Such figs must go into jam stock, with consequent reductions in returns. Heavily infested drying figs are less acceptable to packers, being lighter in weight and having a warty appearance.

The scale passes the winter as adult females on the bark of the fig tree. Most of the live scales are on the one- and two-year-old wood, but they can be found on any portion of the tree where there is succulent bark. Overwintered females lay eggs from February to June. Hatching begins early in April and continues until well into June. Most of the crawlers go to the leaves and settle there, but a small percentage settle on the fruit and a few on the bark. The scales on the leaves are smaller, lighter colored, and somewhat

different in shape from the overwintering scales on the twigs. Eggs laid by the earliest of these scales begin to hatch about mid-June. At that time crawlers from both spring and summer eggs are present on the leaves. Additional broods develop during the summer and on the twigs in the fall. The female scales on the twigs are fertilized in the fall and form the overwintering brood.

Control following the use of various concentrations of dormant oil at different times was measured by the mortality among the overwintering scales, the number of summer scales established on the foliage near the end of the first brood, and the percentage of infested fruit at harvest. The 2 per cent dormant oil sprays did not give satisfactory control. When 3 per cent dormant oil, 3 per cent dormant oil with 3 per cent lime-sulfur, and 4 per cent dormant oil sprays were used, the results were good. Effectiveness increased in the order named. The susceptibility of the scales to the oil sprays varied little through the winter, from December to early March. When the spraying was delayed until the females began to lay eggs, some of the eggs hatched, but few of the young lived after crawling on the oiled bark. Although the 3 per cent oil with 3 per cent lime-sulfur spray gave results about as good as the 4 per cent spray, the cost of materials was greater and the spray was more disagreeable to apply.

The mortality of overwintered scales following use of ovicides with dormant oils during the egg-laying period was no greater than when oils alone were used. Fewer eggs, however, hatched when the ovicides were included in the sprays. The advantage from the use of ovicides was more apparent than real, however, because few of the young lived after crawling on bark oiled by dormant oils alone, and the numbers of first-brood scales that established themselves on the leaves following the use of the two types of spray were about equal. Addition of the ovicides increased the cost of the sprays, but did not increase their effectiveness.

Fig scale infestation was controlled by 2 per cent light summer-oil sprays put on in May, when first-brood crawlers were still settling and before any of the summer scales were mature. Most of the scales were on the leaves at that time, and covering all of them with oil was more difficult than in the winter.

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A TECHNIQUE FOR SEPARATING MILKWEED SEEDS FROM SILKS

One of the chief drawbacks in using the milkweed bug, *Oncopeltus fasciatus* Dallas, as a laboratory test insect has been the problem of supplying it with food. In the past, milkweed seeds have been separated from the silks by hand: a slow laborious process. A pot-type vacuum cleaner with a removable dirt pan, such as the commercial Multi-vac Spencer, is a valuable aid in separating these seeds.

The pods are opened by hand into a large flat container. Then the seeds and silks are drawn into the cleaner through the hose. Most of the seeds settle to the bottom of the cleaner, into the dirt pan, while the silks cling to the cloth bag. If the cleaner is laid on its side after the contents of 100–200 pods are run through, the seeds and heavy debris are retained in the pan and few of the silks fall down into this pan. The seeds can then be sifted through a coarse screen to eliminate the debris.

If the motor is turned on while the dirt pan is removed, the silks and lighter debris will be packed into the bag and they may be easily removed and disposed of as desired.

The method of separation described here is approximately 4 or 5 times faster than hand separation. It is also more efficient, and cleaner than hand separation.

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The Effect of Soil Soluble Salts and Cultural Practices on Mite Populations on Hothouse Tomatoes

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The two-spotted spider mite, *Tetranychus bimaculatus* Harvey, has been the cause ef much concern to growers of greenhouse vegetables. In Ohio, where the hothouse vegetable industry is a large one, this mite attains great economic importance, especially on tomatoes. Once a mite infestation has made its appearance in a crop it will spread rapidly if not checked. The costly control measures that must be directed against infestations can be appreciated, for instance, when the situation demands fumigation of large acreages several times during the course of one growing crop.

To prevent infestations through carry-over from the previous crop, greenhouse operators usually steam-sterilize the soil and fumigate the greenhouse with sulfur or azobenzene. In spite of precautions, however, some greenhouses observed through a period of years seem to have a regular recurrence of mite infestations. Others, in contrast, seldom if ever have such infestations.

In order to investigate possible relationships existing between soil or cultural factors and mite infestations, these studies were undertaken in 1946. A factor which encouraged the investigation was the work reported by Page (1946) who found that Ohio vegetable greenhouse operators were maintaining fertilizing programs which, apparently, were needlessly heavy.

Experimental.—In order to determine the mite population of a given greenhouse, 100 tomato leaflets were taken at random and the mites found thereon were counted. This number was the population value attributed to that greenhouse. There were 24, 47, and 49 greenhouses studied in June 1946, 1947, and 1948, respectively. These greenhouses averaged 3 acres in size and were located mainly in northern Ohio.

Soil samples were taken concurrently with the population surveys of 1947 and 1948; the cropping system and the type of mulch used in each greenhouse were also recorded. Soil samples were not taken in 1946. Page (1946) reported the analyses and conductivity of greenhouse soil samples taken during 1944 and 1945; since these soils usually received the same treatment each year, it was assumed that this evaluation of soluble salt concentrations would be a close indication of the values existing in 1946.

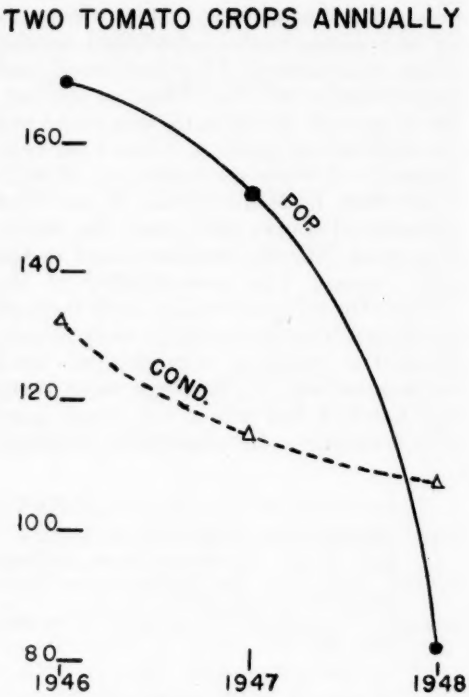

Fig. 1.—The relationship of two-spotted spider mite populations and specific conductivity of soil soluble salts in Ohio vegetable greenhouses growing two tomato crops annually. Scale indicates both the average mite population per 100 leaflets and the specific conductivity of the soil.

The method followed in determining soluble salts was one set forth by Merkle & Dunkle (1944) in their study of soluble salt content of greenhouse soils as an aid in diagnosing soil problems. This method is based on an electrical bridge measurement (specific conductivity) of the ionized salts resulting from a 1:2, soil:water extract, and expressed as reciprocal ohms times 10^{-5}.

RESULTS AND DISCUSSION.—*Mite Population, Cropping System, and Soluble Salt Studies.* When the mite population data were being evaluated, it was found that these data fell into two groups: in the first, the greenhouse operators grew two tomato crops annually; and in the second, the cropping system involved one or more alternate vegetable crops, *i.e.*, radishes, cress, or lettuce. This is shown in table 1. It will be noted that the population totals of the two groups differed widely. Conversely, when the specific conductivity values were compared, the differences were not great. The alternate cropping system, therefore, suggests itself as a major factor in discouraging mite infestations in these vegetable greenhouses.

When the data from greenhouses growing two tomato crops in 1946 were analyzed statistically, a significant positive correlation was found to exist between electrical conductivity (reciprocal ohms) of soluble salts and the mite population. That is to say, the higher the specific conductivity the higher the mite population.

The straight-line relationship evident the first year was not found in the two subsequent surveys and analyses. Scattergrams of the data make apparent a relationship in which the bulk of the mite population and specific conductivity observations occur in the low ordinates. As is shown in figures 1 and 2, there has been a decrease of both mite populations and soluble salts during this period.

An explanation of these phenomena may be found in the fact that, following the report by Page in 1946, the greenhouse operators were made aware of the high concentration of mineral elements in their soils and accordingly decreased their fertilizing programs. Records taken during the course of this study indicate that the amount of fertilizer applied per acre has been reduced approximately 36 per cent over a 5-year period.

It was not the purpose of this investigation to consider the individual ions which constitute soluble salts and study their influence on mite populations.

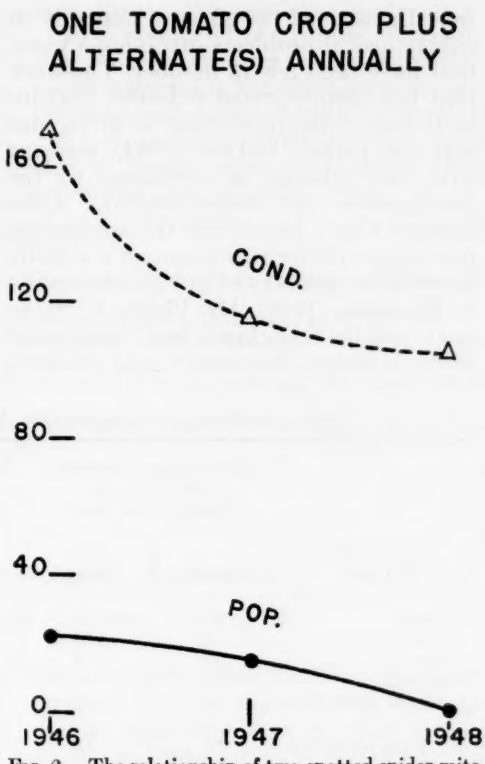

FIG. 2.—The relationship of two-spotted spider mite populations and specific conductivity of soil soluble salts in Ohio vegetable greenhouses growing one tomato crop and one or more other vegetables annually. Scale indicates both the average mite population per 100 leaflets and the specific conductivity of the soil.

Table 1.—Summary of studies: specific conductivity of soils, mite populations, and cropping systems in Ohio vegetable greenhouses.

YEAR	TWO TOMATO CROPS ANNUALLY			ONE TOMATO CROP PLUS ALTERNATE(S) ANNUALLY		
	Number of greenhouses studied	Sp. conductivity $\times 10^{-5}$ mhos[1]	Population average per 100 leaflets	Number of greenhouses studied	Sp. conductivity $\times 10^{-5}$ mhos[1]	Population average per 100 leaflets
1946	14	133	169	10	170	23
1947	25	115	152	22	116	16
1948	26	107	82	23	104	1

[1] mhos = reciprocal ohms.

Investigations of the effect of minerals on entomological problems involving a plant host have been few in number. The work that has been reported indicates that insects vary in their reaction to given ions and host plants. McGarr (1942), working with the relation of fertilizers to the development of cotton aphid, *Aphis gossypii* Glov., found that the application of nitrogenous fertilizers caused a definite increase in numbers of aphids. According to Haseman (1946), Dr. Phillip C. Stone has found that the chinch bug "thrives and matures faster, lives longer, and produces more offspring when nitrogen is withheld from the nutrient solutions on which corn plants were grown as food." Dahms (1947), working with the chinch bug on sorghum plants, found that the bugs laid more eggs on plants growing in solutions high in nitrogen or low in phosphorus than on the same varieties growing in solutions low in nitrogen or high in phosphorus.

In this study, specific conductivity has been used as an index of ionic concentrations and suggests itself as a possible approach to entomological problems of this nature. Investigations of the effect of specific mineral elements are now in progress. It remains to be seen how these ions influence a mite population.

MITE POPULATION AND MULCH STUDY.—Mulches have been frequently blamed for mite introductions and infestations, since mites occur on a variety of forage crops used by greenhouse operators for mulching tomatoes. In order to determine whether the frequency of mite infestations and the type of mulch used were interrelated, observations were made on each of the vegetable greenhouses studied during the 3-year period. Table 2 gives a summation of the results.

A straw mulch has been generally accepted by greenhouse operators as the mulch least likely to introduce mites. The data substantiate the popularity of the straw mulch but do not substantiate the belief. Clover mulch has been thought to be a probable source of mites but the data tend to indicate that it was not responsible for mite introductions. The use of the other mulch types is so limited that the data are inconclusive.

Table 2 —Three year summation: Mulch type and mite occurrence study

TYPE OF MULCH	HOTHOUSES GROWING TWO TOMATO CROPS ANNUALLY		HOTHOUSES GROWING ONE TOMATO CROP PLUS ALTERNATE(S) ANNUALLY		TOTAL HOTHOUSES OBSERVED	
	Infested	Mite Free	Infested	Mite Free	Infested	Mite Free
Straw	38	6	6	33	44	39
Clover	5	1	2	6	7	7
Hay	3	3	1	1	4	4
Soybean	5	0	0	2	5	2
Peanut shell	3	1	0	4	3	5
Total observed	54	11	9	46	63	57

It is also interesting to note the differences between the numbers of the infested and non-infested greenhouses under the two cropping systems.

SUMMARY.—Possible relationships between soil or cultural factors existing in Ohio vegetable greenhouses and the two-spotted spider mite, *Tetranychus bimaculatus* Harvey, occurring on tomatoes were investigated. It was found that the type of cropping system employed in a given greenhouse was a determining factor for mite occurrence or degree of infestation. During this study, more than 10 times as many mites were found in greenhouses where two tomato crops were grown annually than in greenhouses where the annual tomato crop was alternated with radishes, cress, or lettuce.

A significant positive correlation was found to exist the first year between the specific conductivity or soluble salt content of the soil and the mite population. This relationship was not evident in the two subsequent years. Both the specific conductivity of greenhouse soils and the mite population, however, showed a

decrease over the 3-year period of the study. This was apparently due to a decrease in the use of fertilizer by the greenhouse operators.

The soluble salt content of soils is an index of ionic concentrations and suggests approaches to certain entomological problems involving inter-relationships between soils, plants, and plant-feeding forms.

Type of mulch had no apparent relationship to mite occurrence. A straw mulch apparently did not discourage mite introductions and a clover mulch apparently did not encourage introductions. Inconclusive results were obtained on three other less popular mulch types.

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Aphids on Flue-Cured Tobacco

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During the latter part of July 1946, aphids were observed to infest flue-cured tobacco heavily in small irregular spots in three tobacco fields of Pittsylvania County Virginia. In 1947, the insect appeared in more injurious numbers and caused slight to moderate damage to some tobacco. The green peach aphid, *Myzus persicae* (Sulzer) was probably the most common species involved. The distribution of aphids in the same field and from field to field was irregular. Infestations observed were generally spotted over a given field and in no instance was there a general distribution. There was a marked preference for shaded areas. Aphids were noted to persist on tobacco suckers after harvest until the plants were killed by frost.

In 1948, heavy infestations of aphids were noted on tobacco plants in several plantbeds. Aphid populations ranged from slight to abundant on newly set tobacco, and some growers sustained serious losses during the season where adequate control measures were not carried out at the proper time.

NATURE OF THE INJURY.—Mature tobacco heavily infested with aphids showed a premature yellowing of the leaves with a firing of the tissue around the margins and particularly at the base of the petiole. Necrotic tissue was often noticeable on mature leaves (Fig. 1). The leaves were generally coated especially on the upper surface with honeydew, on which a black, sooty, moldlike growth developed. This condition was noticeable first on the lower leaves and later on the leaves further up the stalk. Cast skins of aphids were generally found adhering by the hundreds to the under sides of the leaves. Such injury reduced the quality and value of the leaf.

FIG. 1.—Severe aphid injury on mature tobacco leaves.

NATURAL CONTROL.—Aphid predators were present in most infested tobacco fields and were generally sufficient to hold the aphids in check under conditions of lightly infested tobacco. The convergent lady beetle. *Hippodamia convergens* Guer., was the most abundant predator. As many as 30 beetles and 47 larvae of this species were counted on one heavily infested plant. The two-spotted lady beetle, *Adalia bipunctata* L. was present in some fields. Several other species of the family Coccinellidae were found to a lesser extent. Syrphid fly larvae, mostly *Sphaerophoria cylindrica* (Say), were found on most plants infested with aphids. Larvae and adults of *Chrysopa* spp. were also found. During a period of hot, dry weather in 1947 and 1948, a heavy mortality of aphids occurred. This condition was so striking that a given field often appeared to have been treated with some effective chemical, inasmuch as hundreds of dead aphids were noted adhering to the leaves and stalk of the plants. Samples of these aphids were collected and forwarded to Mr. Paul Lentz, Division of Micology and Plant Disease Survey, U. S. Department of Agriculture. It was reported that no entomophagous fungi were found; however there was an abundance of sterile mycelium, as well as yeastlike forms in the bodies of the aphids.

CONTROL WITH INSECTICIDES.—In preliminary tests during 1947, nicotine dust, 3 per cent and nicotine spray, 1 to 400 were not effective, thus attention was turned to some of the newer organic insecticides. Small-scale field tests with parathion used in a 1 per cent dust and in spray containing 1 pound of 15 per cent wettable powder in 100 gallons of water, gave perfect control in replicated plots. Hexaethyl tetraphosphate applied as a spray had a similar toxicity.

PLANTBED EXPERIMENTS, 1948.—A tobacco plantbed located at the Station was noted to have a heavy, general infestation of aphids on May 27. This plantbed was divided into small plots, each consisting of an area of 2 square yards. A buffer space was left between plots and cloth covers were used on either side of the plot being treated. Parathion was used as a 1 per cent dust and as a spray containing 1 pound of 15 per cent wettable powder to 100 gallons of water in the tests, each treatment being replicated four times. The dust was applied at the rate of 1 pound and the spray, 6 gallons per 100 square yards. The plants were approximately 6 to 8 inches high at the time of treatment. A pre-treatment count of aphids was made by drawing 10 plants at random and recording all stages of aphids found on each plant. Post-treatment counts were made in a similar manner 48 hours after treatment.

Table 1.—Control of aphids on tabacco plants in the plantbed with parathion.[1]

TREATMENT	APHIDS PER 10 PLANTS[2]		PER CENT REDUCTION
	Before Treatment	After Treatment	
Parathion, 1% dust	773	0	100.0
Parathion, 1 lb. 15% wettable powder 100 gal. water	445	2	99.5
Untreated check		565	—

[1] Parathion (*Thiophos 3422*), American Cyanamid Company.
[2] Average 4 replicates.

The results given in table 1 indicated that parathion at the rates used was highly effective against aphids in tobacco plantbeds. On the basis of these data it is conclusive that a treatment in the plantbed would be of importance in preventing a rapid build-up of aphids on newly set plants in the field, the original infestation being carried from the plantbed. Inasmuch as parathion has residual toxicity against aphids, this treatment would offer several days' protection against the winged forms.

FIELD EXPERIMENTS.—Field experiments were carried on against aphids on tobacco during 1948 at three locations, the treatments being applied on different dates. A complete randomized-block design was used with buffer space consisting of one row between plots. The dusts were applied to the upper surface of the leaves, no special effort being made to cover the under side. The sprays were applied lightly with hand spray equipment, both surfaces of the leaves being covered. Counts of aphids were made before and after treatments. Ten plants were selected at random from the two center rows of each plot and all stages of aphids recorded. Aphid counts were made by counting all stages of the insect on the bud and five leaves selected at random at different heights on the plant. Post-treatment counts were made 48 hours after the treatments were applied.

The tobacco field selected for experiment 1 was a uniform planting of Virginia Gold tobacco. At the time of the treatment on June 21, the plants were approximately 42 inches high and the infestation of aphids was general. The plots were 0.0125 acre in size, and each treatment was replicated three times. The treatments were made during exceptionally favorable weather. The dusts were applied to both sides of the row with a rotary hand-operated duster at the rate of 17 pounds per acre. The sprays were applied at the rate of 65 gallons per acre.

Table 2.—Control of aphids on flue-cured tobacco with parathion, tetraethyl pyrophosphate,[1] and 40-percent nicotine sulphate.

Treatment	Aphids per 10 Plants[2] Before Treatment	After Treatment	Per Cent Reduction
Parathion, 1% dust	2602	0	100.0
Parathion, .5% dust	1789	26	98.5
Parathion, 1 lb. 15% wettable powder 100 gal. water	2714	35	98.7
Tetraethyl pyrophosphate, 10% 2 pints 100 gal. water	2781	23	99.2
Nicotine sulphate plus soap, 2 pints 100 gal. water	2940	2573	12.2
Untreated	2884	2810	—

[1] From Woolfolk Chemical Works.
[2] Average 3 replicates.

The different materials tested and the results obtained are given in table 2. All treatments except nicotine sulphate resulted in high reductions in aphid populations. A 1 per cent parathion dust showed slightly better performance than the 0.5 per cent strength. Tetraethyl pyrophosphate gave good results at the rate tested. At the 1 to 400 rate nicotine sulphate was ineffective.

The small field selected for experiment 2 was a uniform planting of Yellow Special tobacco. Plots 0.0133 acre in size were used, and each treatment was replicated three times. The plants at the time of the treatment on June 30 were about 15 inches high and had a moderate infestation of aphids. Dusts were applied with a knapsack duster at the rate of 10 pounds and the sprays at 40 gallons per acre.

The different materials tested and the results obtained are given in table 3. All treatments gave large reductions in aphid populations. The 1.5 per cent gamma benzene hexachloride dust was slightly less effective than parathion at the 0.5 and 1 per cent strengths. This may be attributed to the slower action of the benzene hexachloride. Parathion and tetraethyl pyrophosphate had about the same efficiency as in the preceding experiment.

Table 3.—Control of aphids on flue-cured tobacco with parathion, tetraethyl pyrophosphate, and benzene hexachloride.[1]

Treatment	Aphids per 10 Plants[2] Before Treatment	After Treatment	Per Cent Reduction
Parathion, 1% dust	540	0	100.0
Parathion, .5% dust	338	6	98.2
Benzene hexachloride, 1.5% gamma dust	342	20	94.1
Tetraethyl pyrophosphate, 10% 2 pints 100 gal. water	636	4	99.3
Benzene hexachloride, 25% gamma 2 lbs. 100 gal. water	714	4	99.4
Untreated check		750	—

[1] B.H.C. (*Isotox*), California Spray-Chemical Corp.
[2] Average 3 replicates.

The purpose of experiment 3 was to compare the effectiveness of 0.5 tand 1 per cent parathion in larger plots with a greater number of replications. The plots selected were a uniform planting of Virginia Gold tobacco. They were 0.05 of an acre in size, and each treatment was replicated four times. At the time of the treatments on July 1, the plants were approximately 30 inches in height and were heavily infested with aphids. The dusts were applied with a knapsack duster at the rate of 15 pounds per acre.

Table 4.—Comparative effectiveness of 0.5 and 1 per cent parathion dust against aphids on tobacco.

Treatment	Aphids per 10 Plants[1] Before Treatment	After Treatment	Per Cent Reduction
Parathion, 1%	4505	3	99.9
Parathion, 0.5%	3547	54	98.8
Untreated check		3840	—

[1] Average 4 replicates.

The results are presented in table 4. Both dust treatments gave a high reduction in aphid populations, which compared favorably with results obtained in the two preceding experiments. As in the two previous tests a 1 per cent parathion dust gave a slightly better performance than the .5 per cent dust.

RESIDUAL EFFECT OF PARATHION.—A small plot of tobacco was dusted lightly

with 1 per cent parathion dust, complete coverage being obtained on both surfaces of the leaves. Following the treatment, tobacco leaves were collected on the first, third, fifth, seventh, ninth and eleventh days and aphids were caged on the under side in 50 mm. glass tubes one inch in height. The glass-tube cages were placed at different locations on each leaf, a tanglefoot barrier being used around the top to prevent migration. The leaves were placed on moist blotting paper, the petioles being wrapped in absorbent cotton which was kept saturated with water to prevent desiccation. The results are given in table 5. These data indicate that parathion, 1 per cent dust, has highly effective residual value against aphids on tobacco for a period of at least 7 days, but its toxicity rapidly decreased after that period. Forty-one per cent of the caged aphids were dead after 9 days. Only 4 per cent were dead after 11 days.

Table 5.—Residual effect of treatments with 1 per cent parathion dust used to control aphids on tobacco when caged on treated and untreated leaves at varied intervals after treatment.

Days	Aphids Caged After Treatment	Number	Per Cent Aphids Dead After— 24 hours	48 hours
1	Treated	226	100	
	Not treated	112	0	
3	Treated	276	100	
	Not treated	148	2	
5	Treated	235	96	98
	Not treated	152	2	4
7	Treated	231	44	92
	Not treated	142	1	4
9	Treated	110	9	41
	Not treated	155	0	3
11	Treated	267	1	4
	Not treated	160	0.6	3

SUMMARY AND CONCLUSIONS.—Aphids are an important potential pest of flue-cured tobacco. The insect was first observed to infest heavily flue-cured tobacco in 1946 and has been on the increase during the following two years.

Beetles and larvae of the family Coccinellidae are important predators and under conditions of a light infestation may hold the insect in check. These insects were readily destroyed by the new organic insecticides under investigation.

Nicotine sulphate was not effective against aphids on tobacco at a rate economical for the grower to use. Parathion, tetraethyl pyrophosphate, and benzene hexachloride all showed a high degree of efficiency in the control of this aphid. No plant injury was observed from the use of either of the chemicals and there was apparently no effect on the curing. Information is lacking on the effect on the burning qualities and flavors of the tobacco.

No residue problem is involved with the use of tetraethyl pyrophosphate inasmuch as it volatilizes rapidly and is effective within a short time after mixing. With the relatively low concentration used it was necessary to wet the aphids to obtain a high degree of control. Complete coverage is difficult, inasmuch as the aphids are largely found on the under side of the leaves.

Parathion dust was highly effective when the application was made without making a special effort to cover the under side of the leaves. Good control has been noted where the coverage was incomplete. It was demonstrated that 1 per cent parathion dust has residual value against aphids on tobacco for at least 9 days after treatment. The possible use of parathion in the practical control of aphids on flue-cured tobacco will depend to a large extent on the residue hazard.

Parathion and tetraethyl pyrophosphate are both highly toxic to warm-blooded animals and their use cannot be advocated without due warning.

The Tobacco Stalk Borer in Western Mexico

A. M. Woodside,[1] *Staunton, Virginia*

The tobacco stalk borer, *Trichobaris mucorea* (Lec.), does not occur in any important tobacco growing region of the United States, and it has received very little attention from economic entomologists. With the exception of the work of McKinney, who studied the biology and control of this weevil at Tempe, Arizona, in connection with an attempt to grow tobacco of a high nicotine content in that state, there seems to have been no study of this borer. The results of McKinney's work have not been published. Chittenden (1902) reported on *T. mucorea* as a pest of potato in Texas, drawing most of his material from correspondence. Barber (1935) is of the opinion that the account by Essig (1915) of the potato stalk borer in the Imperial Valley of California, and the Arizona record of Morrill (1915), both under the name of *T. trinotata*, probably deal with *T. mucorea*.

Trichobaris mucorea is a very serious pest of tobacco in the State of Nayarit, Mexico, where it causes heavy losses. The coastal plain of Nayarit, is the most important tobacco producing region of Mexico. Preliminary studies of the biology and control of the stalk borer were started at Santiago Ixcuintla, Nayarit, in November 1947, and the work herein reported was conducted there between November 17, 1947, and March 3, 1948. At the time the work was started the earliest of the tobacco plant beds had been seeded about 6 weeks, and a few plants were almost large enough to transplant, but transplanting had not been started.

Life History and Habits.—Tobacco stalk-borer adults were present on the larger plants in the plant beds at the time of the first examination on November 17, but they were much less common than they became a short time later. Population counts made between December 5 and January 22 showed that, over relatively short periods, there were wide variations in the number of beetles found in the plant beds. These apparent fluctuations in population seem to have been caused by differences in activity rather than by differences in actual population. The beetles are more active, and thus more readily observed or collected, when the temperature is high. They exhibit a preference for the larger plants in a bed and few are found on the smaller plants. Thus the population dropped sharply when the plants were taken from a given part of a bed for transplanting. Irrigation of the plant beds was discontinued about the middle of January and this was followed by a sharp drop in the beetle population. The population in the tobacco fields, however, was increasing rapidly at this time.

Stalk-borer adults are inactive at temperatures below 60°F., and few of them are found on the plants at such temperatures. During the period of these studies it was usually cool enough in the early morning to cause the beetles to drop off the plants. As the temperature rises in the morning their activity increases, and many beetles may be found walking about on the tops of the leaves at 70°F., if the air is still. At temperatures above 80°F. they fly readily, often making repeated short flights. Activity is decreased by wind, which causes them to seek shelter, and few of them appear on the plants on cloudy days. The males are more active than the females, which are more commonly found on the stems or petioles where most of their feeding and egg laying is done. Males predominated by about three to one in collections made by picking the beetles from the tops of the plants.

Beetles collected in the plant beds were used for life history studies in the insectary, being placed in fruit jars with a small amount of lightly packed, moist soil in the bottom. Fresh tobacco plants were set in the soil in these cages daily. Mortality was high among the beetles in the insectary, and many females died before depositing any eggs. Most of the females had probably deposited eggs before being captured, so that the oviposition records are lower than those that might have been obtained from beetles reared in captivity. Oviposition records were obtained for 17 females. The individual records covered periods varying from 15 to 98 days, and the female having the

[1] The work reported in this paper was conducted while the author was on leave of absence from his duties with the Virginia Agricultural Experiment Station, and was employed by a tobacco company in Mexico

longest record was still living when the work was terminated. The number of eggs deposited by individual females varied from 17 to 128, the average per female being 61.8 eggs.

The eggs of the tobacco stalk borer are deposited singly in any part of the host plant in which the female can excavate a suitable hole. An occasional egg is thrust into some natural crevice of the plant. Most of the eggs deposited in the plant beds are placed in the stems, a few being placed in the petioles. As the plants increase in size, an increasing percentage of the eggs are deposited in the petioles and midribs. Egg punctures are of two types, occurring in approximately equal numbers. Both types may be made by the same female in one plant in the course of 24 hours. The simplest consists of an excavation into the tissue of the plant, slanted so that it extends laterally 2 to 3 mm. under the surface layers. The egg is pushed into the short tunnel thus formed. The other type is more commonly found on plants or parts of plants on which the layer of succulent tissue overlying the hard woody layer is relatively thin. It consists of a shallow, crescentic excavation, and the egg is placed in a small hole under the center flap or tongue of this excavation.

The egg of the tobacco stalk borer is oval in shape; the diameter varies from 0.4 mm. to 0.5 mm., and the length from 0.7 mm. to 0.9. mm. It is light yellow or cream in color when first deposited. This color becomes intensified during the first 24 hours, but it fades out as the egg approaches hatching condition. When ready to hatch the egg is almost transparent, except for the black head of the larva. The eggs deposited November 26 to February 12 hatched in 7 to 17 days. The average length of the incubation period was 9.2 days.

The newly hatched larva is almost transparent, with a slight greenish-yellow tinge, and the head is black. The young larva feeds within the cavity which enclosed the egg for 24 hours or longer, and then begins to tunnel through the tissues of the host plant. The burrows soon turn black, and appear as more or less distinct dark lines visible through the overlying tissue. These dark lines are very conspicuous on the smaller infested plants, and have given rise to the name *planta rayada*, or "striped plant," as such a plant is known. The larva may tunnel in any direction, and it often follows a spiral course. In the smaller plants the amount of succulent tissue outside the woody layer of the stem is limited, and most of the larvae find their way through this woody layer to the pith cavity of the plant. In the larger plants many of them complete their growth in the tissue outside this layer. Most of the larvae that hatch in the petioles of the small and medium plants find their way down to the stems.

At the end of its feeding period the larva excavates an exit passage almost to the surface of the plant. It then constructs an oval cell of bits of chewed woody tissue, and pupates within this cell. The combined lengths of the larval and pupal stages varied from 39 to 56 days, the average length being 48.7 days. Added to the incubation period, this gives an average length of life, from the deposition of the egg to transformation, of 57.9 days. The adults usually do not emerge for several days after transforming, but no records of the length of this period were obtained. This study was made during the coolest months of the year, and it is possible that development may be more rapid during the warmer months. It appears that the stalk borer may have six overlapping generations per year in Nayarit, but there would be fewer if the adults remain in the old tobacco stems for any considerable length of time before emerging.

HOST PLANTS OTHER THAN TOBACCO.—Beetles reared from borer larvae which were very common in the stems of a ground cherry, *Physalis angulata* L.,[2] in November and early December were determined as *Trichobaris mucrorea* by L. L. Buchanan of the Division of Insect Identification. Adults of the tobacco stalk borer were seldom found on ground cherry, and the larvae present in early December were half grown or larger, indicating that the eggs had been deposited several weeks earlier. Ground cherry plants in the plant beds among tobacco plants were seldom infested. When ground cherry plants were placed in the oviposition cages along with tobacco plants, 75 per cent of

[2] The plant determinations were made through the courtesy of Dr. J. G. Harrar, Director for Agriculture, The Rockefeller Foundation, Mexico, D. F.

the eggs were placed in the tobacco plants. Thus stalk borer beetles will oviposit in this weed, but they prefer tobacco, and evidently abandon ground cherry when tobacco plants become large enough to be attractive. Larvae of the tobacco stalk borer appeared to grow normally in the stems of ground cherry and they reached maturity in these plants in about the same length of time as was required in tobacco. This plant may be of importance in enabling the stalk borer to maintain a fairly high level of infestation when tobacco plants are not generally available, for it is very common.

Larvae believed to be those of *Trichobaris mucorea* were found on several occasions in the petioles of *Solanum diversifolium* Schlecht. This is a very common plant in this region, but it is shrubby and the stems are too woody to provide much food for the larvae of the tobacco stalk borer. During the dry season the petioles are the only parts of the plant that seem succulent enough to support these larvae. The growth of this plant during the rainy season may be more succulent, and if so, it may serve as a host of some importance.

Datura has been mentioned by Essig (1915) and Barber (1935) as an important host of *Trichobaris mucorea*. *Datura* was not common in the area around Santiago Ixcuintla, and no plants of this genus were found until late in February. At this time a large patch of a species of this weed was examined carefully, and many of the plants were dissected, but no evidence of infestation by *T. mucorea* or any related species of borer was found. This *Datura* was adjacent to a tobacco field in which the infestation of stalk borer was heavy.

Wild or volunteer tobacco plants may be found quite commonly in the area where these studies were conducted, and many of these were examined for borer infestation. Such plants are usually less heavily infested than the tobacco plants in nearby fields. It is possible that they were less attractive to the ovipositing beetles because they were older and less succulent than the plants in the fields.

NATURAL ENEMIES.—Natural enemies appeared to be of little importance. No parasitization of borers in tobacco was observed, but a few parasitized larvae were found in the stems of *Physalis angulata*. No adults of these parasites were obtained. The larvae of a beetle were quite generally predaceous on tobacco stalk-borer larvae in the stems of ground cherry. These beetle larvae were common in this plant, and were much more injurious to it than were the stalk-borer larvae. In every case where one of these larvae is known to have encountered a larva of *Trichobaris mucorea*, the latter was destroyed. Beetles reared from these larvae were tentatively determined as *Langurites* sp. by W. S. Fisher of the Bureau of Insect Identification.

NATURE AND EXTENT OF INJURY.—Approximately 29 per cent of the tobacco plants taken from the plant beds for transplanting were infested by the tobacco stalk borer. Of these 19 per cent contained eggs, 7 per cent contained larvae, and 3 per cent contained both eggs and larvae. There were 35 eggs and 11 larvae per 100 plants. The larvae were small, and had not caused noticeable injury to the plants, although the dark lines indicating their burrows were conspicuous.

When tobacco is transplanted there follows a period of a week to 10 days, or even longer, during which the plants make no growth. The part of the plant above the surface of the soil dies, and the plant shows no signs of life for several days. Then a bud beneath the surface starts growth and sends up a shoot which will form the central stem of the plant. Plants which contain borer larvae when transplanted are very likely to be killed during this period, since the tissue being devoured is not being replaced. In an experimental tobacco field, planted December 2 and 3, 8 per cent of the plants were killed by borers at this early stage.

Plants in which the borer eggs hatch after the plants are set in the field usually survive, unless other factors contribute to their weakening. The feeding of the borers in such plants, however, often weakens or kills the first bud that starts growth, resulting in the production of several small stems or suckers instead of a central stem. In the experimental field at Santiago Ixcuintla 20 per cent of the plants produced suckers as a result of borer attack. Such plants produce a relatively small quantity of inferior tobacco. This type of injury is responsible for the greater part of the losses caused by the tobacco stalk borer. In other parts of Nayarit, tobacco

fields were observed in February in which 50 per cent, or more, of the plants had produced several suckers instead of central stems as a result of borer injury when small. In many of these fields no plants could be found that did not show evidence of borer injury.

Larvae that hatch from eggs deposited after the plants are transplanted do not cause severe injury unless there be several of them in one plant. Sometimes a single borer may kill or weaken the center bud of a plant by feeding near the growing tip, but such injury is not common. The presence of a borer near the tip of even a large plant may weaken its growth, however, resulting in the production of suckers, but this injury is much less severe than that which occurs in smaller plants. Occasionally stems, petioles, or midribs are so weakened by the feeding of borers that they break, but breakage is not an important cause of damage.

Table 1.—Insecticidal treatments applied to tobacco in field experiment for control of the stalk borer, Santiago Ixcuintla, Nayarit, Mexico, December 1947 and January 1948.

Series	Treatments Applied on Designated Dates		
	Dec. 22 to Jan. 16, 6 Treatments	Jan. 23	Jan. 30
A	DDT spray[1]	None	None
B	DDT dust[2]	Chlordan[3] dust	Chlordan dust
C	DDT dust	None	None
D	DDT dust	DDT dust	DDT dust
E	None	None	None

[1] Four pounds of 25 per cent wettable powder per 100 gallons.
[2] Ten per cent.
[3] Prepared by diluting a 50 per cent wettable powder with fullers earth to obtain a dust containing 5 per cent of clordan.

INSECTICIDE TESTS.—A field of tobacco was set aside for insecticide tests, and an experiment was laid out in the form of a latin square. Failure to receive supplies prevented the carrying out of this experiment as planned, since no insecticide except DDT was available until late in January. DDT spray, 4 pounds of 25 per cent wettable powder per 100 gallons; and DDT dust, 10 per cent, were applied to certain plots in this field, beginning on December 22. Six applications were made, the last on January 16. After small amounts of other insecticides were obtained,[3] a 5 per cent chlordan dust was applied to a series of plots which previously had been treated with DDT dust, and the DDT dust was continued on a second series. The treatments applied in this experiment are shown in table 1.

The results of these treatments were evaluated by counting the stalk-borer eggs in a sample of plants from each plot. Sufficient time was allowed to elapse between the application of the first treatment and the taking of the first samples for the hatching of all eggs deposited before treatments began. The samples taken on January 6 consisted of ten plants from each plot; those on January 20 of five plants from each plot; and those on February 7 of 12 inches from the top of each of 10 plants from each plot. The results of these examinations are shown in table 2. The number of larvae found in the plant samples is not shown, for many of these would have hatched from eggs deposited before treatments were started. There was, however, a substantial reduction in the number of larvae in the treated plots as compared with the checks.

Table 2.—Results of insecticidal treatments applied to tobacco in field experiment for control of the stalk borer, Santiago Ixcuintla, Nayarit, Mexico. December 1947 and January 1948.

Series	Number of Eggs per 100 Plants on Designated Dates			
	Jan. 6	Jan. 20	Feb. 7[1]	Feb. 20[1]
A	20	20	14	18
B	32	28	2	11
C	22	12	26	29
D	16	24	14	15
E	134	108	98	37

[1] Counts on these dates were based on 12 inches from the top of each plant in the samples.

A final examination on February 23 showed that DDT spray had retained its effectiveness longer than DDT dust. Chlordan dust was also more effective than DDT dust in preventing oviposition 3 weeks after the last application.

A small-scale experiment was laid out in a plant bed late in January, and sprays were applied on January 29 and February 4, and 11. The following insecticides were used at the rates indicated per 100 gal-

[3] Small amounts of several insecticides were furnished by Dr. J. J. McKelvey, Jr., Entomologist, The Rockefeller Foundation, Mexico, D. F.

Table 3.—Results of the application of sprays to plots in tobacco plant beds for control of the stalk borer, Santiago Ixcuintla, Nayarit, Mexico, January and February 1948.

Treatment	Infestation on Designated Dates			
	Feb. 14		Feb. 19	
	Plants Containing Eggs	Eggs per 100 Plants	Plants Containing Eggs	Eggs per 100 Plants
	Per Cent		*Per Cent*	
DDT	17	22	10	18
Chlorinated camphene	25	32	16	25
Benzene hexachloride	7	10	0	0
Chlordan	20	25	10	10
Check	42	75	35	80

lons: 4 pounds of 25 per cent DDT, 2 pounds of 50 per cent chlordan, 3 pounds of 50 percent (6 per cent gamma isomer) benzene hexachloride, and 2 pounds of 50 per cent chlorinated camphene. Samples of plants from these plots were examined for eggs on February 14 and 19, and the results are presented in table 3. Benzene hexachloride was the most effective material in preventing oviposition, and dead borers were found in plants which had been sprayed with this insecticide. Chlordan, DDT, and chlorinated camphene were less effective.

Caged stalk-borer beetles were fed upon freshly sprayed foliage taken from the plants in the plant-bed spray experiment. Benzene hexachloride gave the quickest kill of the beetles, while DDT and chlordan were somewhat slower. Chlorinated camphene was the slowest of any of the insecticides in paralyzing and killing the beetles.

SUMMARY.—The tobacco stalk borer is a serious pest of tobacco in the State of Nayarit, Mexico, and causes heavy losses. The eggs are laid in punctures made by the females in plants in the plant beds and in the fields. The most serious injury results from the early infestation. Plants infested in the plant beds are likely to be killed, or to produce suckers, which interfere with their normal growth and the production of good quality leaf. Hosts other than tobacco appear to be of little importance in this area, and no important natural enemies were observed. Benzene hexachloride gave promising results in preliminary tests, while chlordan and DDT were somewhat less effective. Insecticide treatments in the plant bed are the most promising approach to control or reduction of losses.

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REVIEW

The Aphidiinae of North America (Braconidae: Hymenoptera). By Clyde F. Smith. 154 pages, 17 plates, 8×6¼ inches, 1944. Contributions in Zoology and Entomology, No. 6, The Ohio State University, Columbus, Ohio. Price, cloth bound, $3.50.

This is the first comprehensive taxonomic treatment of the Nearctic aphid parasites comprising the braconid subfamily Aphidiinae since Gahan's review of the group in 1911 (Md. Agr. Exp. Sta. Bull. 152). That such a revision was needed is evidenced by the inclusion of 28 new species among the 75 species recognized in this work. Names are finally available for these, many of which have not been recognized as distinct and have often been misidentified. Descriptions are given for the old as well as the new species and these are supplemented by numerous, clear illustrations that are helpful in the interpretation of the keys and descriptions. For the first time the female genitalia of most of our species are illustrated. A complete host index is also included. The collection of the U. S. National Museum served as the principal basis for the study. The author himself, however, had also reared Aphidiinae extensively in different parts of the United States and had assembled a large amount of material with definitely known host records which proved an important aid to an understanding of species limits.

The generic classification, with the division of *Aphidius* and *Trioxys* into subgenera, represents a departure from the earlier treatment of the group. To the reviewer, himself a worker in the Braconidae, this arrangement seems to be sound and to give a better picture of the relationships within the subfamily. Considering the poor condition of much of the available material, including types, and the relative scarcity of clear-cut characters, this revision impresses as being a substantial contribution to our knowledge of an important group of insect parasites. —C. F. W. M.

Experiments for Control of Onion Thrips[1]

J. R. Douglass and F. H. Shirck, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*

The onion thrips (*Thrips tabaci* Lind.) is the major limiting factor in the production of onions in Idaho. Its attacks are sporadic, both as to season and to locality. With the wartime food program came the demand for dehydrated onion products for the use of the armed forces and the Lend-Lease. The hard, or susceptible, varieties of onions are the most desirable for dehydration. During 1942 and 1943 this thrips caused serious losses to growers of onions in this area. Owing to the increased cost of production and the high prices received for commercial onions, these losses were keenly felt by the growers. Since no satisfactory control had been developed for Idaho conditions, the growers and dehydrators requested State and Federal help in developing an effective control.

One of the early recommendations for control of the onion thrips was made by Quaintance (1898), who advised the use of tobacco sprays. Many years later Richardson (1934) found that tartar emetic at 1:400 with a 3-per cent molasses solution was very toxic to adults of the gladiolus thrips *Taeniothrips simplex* (Mor.), and following this discovery tartar emetic sprays came into rather general use. Anderson & Walker (1940) reported that tartar emetic-brown sugar spray controlled onion thrips in the greenhouse, but was less effective when sprayed on onions in the field. The literature concerning the use of tartar emetic for control of thrips was reviewed by Ewart *et al.* (1944).

With the introduction of DDT, benzene hexachloride, and other new and highly efficient insecticides, the outlook for thrips control seems definitely more promising. Smith (1944) showed that DDT sprays were effective in controlling the onion thrips on onions and increasing the yield, but at the low strengths used, were less effective than tartar emetic spray. Lange & Thwaits (1944) found that DDT emulsion spray was superior to tartar emetic-sugar, nicotine sulfate-sugar and nicotine alkaloid sprays, and to a 3-per cent DDT dust. Lang (1946) reported that 3 or 4-per cent DDT dust, preferably with sulfur was a satisfactory substitute for tartar emetic spray. Chapman *et al.* (1947) found benzene hexachloride dust to be as effective as DDT dust or spray. Hoerner & Edmundson (1947) reported that onions sprayed or dusted with DDT or sprayed with a water suspension of benzene hexachloride yielded significantly more pounds of bulbs per acre than those sprayed with nicotine sulfate, or those from untreated checks. These workers also found that various formulations of DDT were superior to tartar emetic-sugar sprays.

An exploratory experiment at the Twin Falls, Idaho, laboratory of the Bureau of Entomology and Plant Quarantine in 1945 showed that DDT was slow in killing onion thrips and that nicotine sulfate (40 per cent nicotine) was faster but did not have the residual effect of DDT. A mixture of DDT and nicotine sulfate was therefore tested in 1946, and again in 1947. The 1946 experiment was designed to determine whether onion thrips could be controlled under southern Idaho conditions by weekly applications of insecticides, and the 1947 experiment was to determine whether the onion thrips could be controlled by three applications of insecticide at 10-day intervals. This is a report of the two seasons' experiments.

Methods.—To obtain the most drastic natural exposure possible, we selected Southport Yellow Globe, reported by Sleesman (1943), as being one of the varieties of onions most susceptible to thrips. The seed was sown in 8-row plots 50 feet long, on April 3 to 5, 1946, and March 20, 1947. The fertility of the soil was low, and the moisture was kept slightly on the dry side. Both of these conditions induce thrips injury. The plants were cultivated and weeded according to practices followed by commercial growers in the locality. In 1946 the 8 replications of 9 treatments and in 1947 the 6 replications of 10 treatments

[1] The project on thrips control is carried on in cooperation with the Idaho Agricultural Experiment Station. Thanks are due to H. C. Manis of that station for reviewing this manuscript, and to H. C. Hallock, K. E. Gibson, J. S. Knudsen, H. W. Mason, and L. A. Winkle, Jr., of the Bureau of Entomology and Plant Quarantine for assisting in the experimental work.

were distributed in the randomized-block arrangement.

The sprays were applied with a power sprayer mounted on a pick-up truck. Driveways were provided in the field so that the spray truck could be driven through it and the plots sprayed without treatment were marked by a white flag as a guide to the spray operator.

Twin Falls city water was used. As the spray tank was being filled with water the other materials were introduced through a medium-fine strainer when the water was approximately level with the agitator

Table 1.—The control of the onion thrips on Southport Yellow Globe onions with different insecticides.

TREATMENT NO.	MATERIALS APPLIED (QUANTITIES PER 100 GALLONS OF WATER)	TOTAL QUANTITY OF SPRAY APPLIED PER ACRE FOR SEASON	THRIPS SURVIVING PER 100 PLANTS	REDUCTION IN THRIPS	YIELD OF ONIONS PER ACRE
	Experiment in 1946 with 5 applications and 8 replicates	*100 gallons*	*Number*	*Per Cent*	*100 lb. bags*
7	DDT 1 lb. (from wettable powder) plus nicotine sulfate 1 qt. plus preparation A 8 fl. oz.	13	24	74	274
1	Benzene hexachloride 5 pounds (from wettable powder)	14	37	82	235
10	DDT 1 lb. (emulsion A)	13	36	74	220
11	DDT 1 lb. (emulsion A) plus sulfur 10 lbs.	12	32	76	219
15	Tartar emetic 4 lbs. plus sugar 4 lbs.	14	99	53	200
5	DDT 1 lb. (from wettable powder)	14	47	70	194
14	Nicotine sulfate 1 qt. plus preparation A 8 fl. oz.	13	136	55	168
13	Methoxy analog of DDT 1 lb. (from wettable powder)	14	154	43	149
17	Check (unsprayed)	0	219	41	123
	Difference required for significance (odds 19:1)	—	—	—	43
	Experiment in 1947 with 3 applications and 6 replicates				
8	DDT 1 lb. (from wettable powder) plus nicotine sulfate 1 qt. plus preparation B 4 fl. oz.	7	69	80	263
4	Chlordan 1 lb. (emulsion C)	8	91	77	256
12	DDT 1 lb. (emulsion B)	8	49	87	254
16	Chlorinated camphene 1 lb. (emulsion)	9	79	79	248
2	Benzene hexachloride 5 lbs. (from wettable powder)	8	98	77	242
9	DDT 1 lb. (from wettable powder) plus hexaethyl tetraphosphate 1 pt. plus preparation B 4 fl. oz.	8	76	84	242
15	Tartar emetic 4 lbs. plus sugar 4 lbs.	8	154	59	229
6	DDT 1 lb. (from wettable powder) plus preparation C 8 fl. oz.	8	139	69	212
3	Methoxy analog of DDT 1 lb. (from wettable powder) plus preparation C 8 fl. oz.	7	136	66	194
17	Check (unsprayed)	0	276	59	179
	Difference required for significance (odds 19:1)	—	—	—	47

using more than 75 feet of hose. The spray was pumped to the boom through a high-pressure hose at 275 to 300 pounds' pressure. A light-weight iron frame to support the spray boom was mounted on bicycle wheels. This 16-nozzle boom covered the 8-row plot at one time, with 2 nozzles per row. Approximately equal amounts of material were applied to all plots. There was some loss of spray in cutting the nozzles on and off.

The treatments were applied in numerical order. The plots to receive a shaft. The accessory materials were added before the insecticides. The sprays were applied immediately after mixing, and agitated during the applications. Between treatments the spray tank was rinsed and the material in the pump, lines, and hose pumped out.

The thrips populations were determined on 10 plants taken at random from the center four rows of each plot the day the sprays were applied and again 4 days later. The method used has been described by Shirck (1948).

Insecticides tested.—In the insecticide sprays the following proprietary preparations were used:

Benzene hexachloride, wettable 50 per cent powders containing 5 per cent gamma isomer in 1946 and 6 per cent in 1947

Chlorinated camphene, 50 per cent emulsion concentrate

DDT, wettable 50 per cent powder

Hexaethyl tetraphosphate, 100 per cent (content of tetraethyl pyrophosphate not stated by the manufacturer)

Methoxy analog of DDT, wettable 50 per cent powder

Nicotine sulfate, 40 per cent nicotine

Methylated naphthalene, a mixture of di- and trimethylnaphthalenes

Preparation A, an emulsifying, wetting or spreading agent consisting chiefly of a phthalic glyceryl alkyd resin

Preparation B, containing 80 per cent of polyalkyl aryl polyether alcohol and 20 per cent of isopropanol

Preparation C, a spreader and sticker containing sodium sulfate of mixed long-chain alcohol, fatty acid esters, and diethylene glycol abietate

The following 3 laboratory-prepared emulsions were tested:

Emulsion A: DDT 1 pound, toluene 576 ml., preparation A 57 ml., water 3 pints. This concentrate was mixed with 8 fluid ounces of preparation A and sufficient water to make 100 gallons of spray. This was tested both with and without sulfur.

Emulsion B: DDT 1 pound, methylated naphthalene 900 ml., preparation B 126 ml., and water 100 gal.

Emulsion C: Chlordan 1 pound, methylated naphthalene 450 ml., preparation B 126 ml., water 100 gal.

These materials were tested in various mixtures as shown in table 1. A mixture of tartar emetic and granulated sugar was also tested.

RESULTS.—The effectiveness of the treatments was based on three criteria—population reduction, surviving populations, and yield. Figures 1 and 2 illustrate the seasonal abundance of onion thrips on untreated onion in 1946 and 1947. The curve obtained in 1947 is similar to the 1946 curve except that on July 21, 1947, there was a drastic decrease in population, the cause of which is not known.

The residual effect of the different insecticides is indicated by the changes in thrips populations during the 4-day periods of observation between the applications as shown in figures 3 and 4 for 1946 and 1947 respectively. In 1946 the lowest populations following the applications, were in the plots treated with

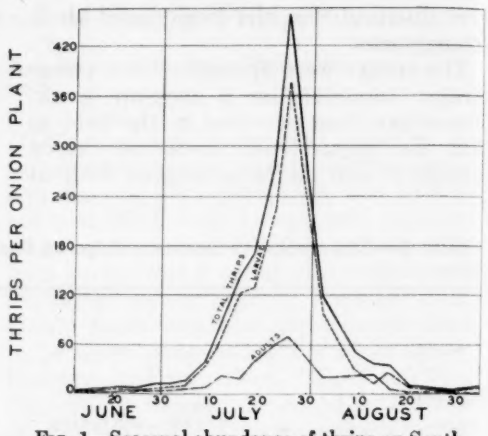

FIG. 1—Seasonal abundance of thrips on Southport Yellow Globe onions grown for bulbs, 1946.

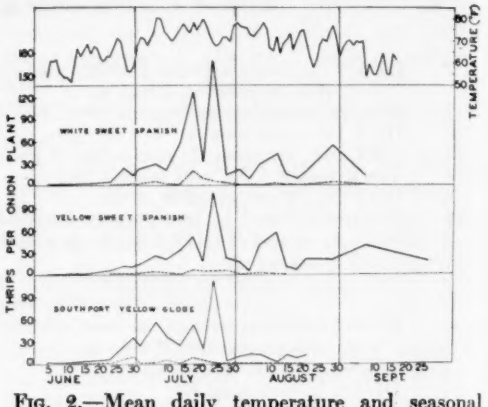

FIG. 2.—Mean daily temperature and seasonal abundance of thrips on different varieties of onions, 1947. Solid line indicates larvae. Dotted line indicates adults.

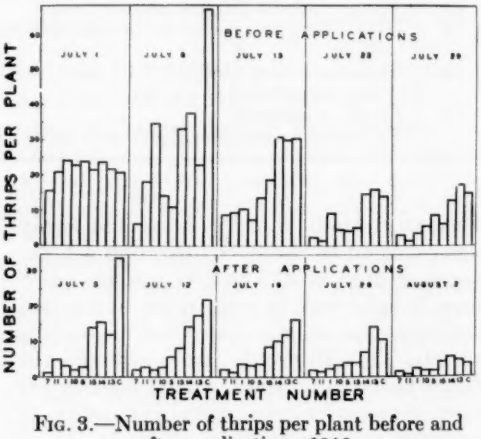

FIG. 3.—Number of thrips per plant before and after applications, 1946.

benzene hexachloride and the 4 DDT sprays. Of these, the DDT sprays were the most effective in keeping the infesta-

tions down until the next application. There were outstanding increases in thrips populations between July 5 and 8 and between July 19 and 22 in the plots treated with benzene hexachloride.

Figure 4 shows that after the first and

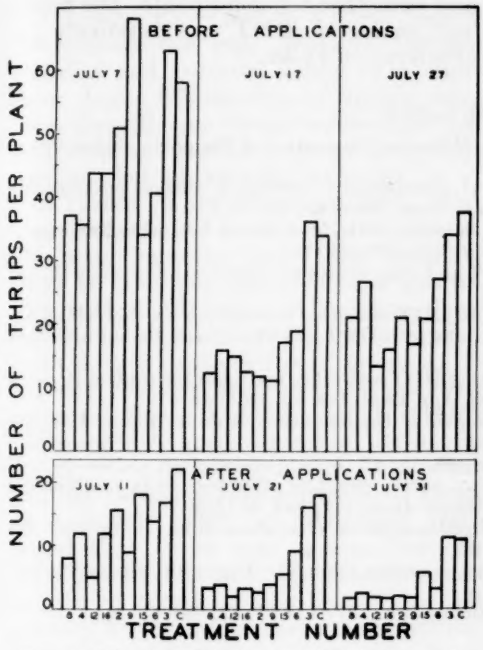

FIG. 4.—Number of thrips per plant before and after applications, 1947.

second applications the greatest reduction of thrips was on plots receiving DDT emulsion. The methoxy analog of DDT gave, in general, the smallest reduction of thrips. There was a striking difference in the appearance of the sprayed and unsprayed plots (Fig. 5).

During 1946 all treatments except the methoxy analog of DDT gave significant increases in yield as shown in table 1. The most effective spray in this respect was the one that included both DDT and nicotine sulfate, which was significantly more effective than nicotine sulfate, tartar emetic, or DDT.

In 1947 the results were similar to those of 1946, the DDT-nicotine sulfate tending to be the most effective and the methoxy analog of DDT of the least benefit. The untreated plots and those sprayed with the methoxy analog of DDT and with DDT in suspension yielded less than any of the others. Promising results were obtained with chlordan, chlorinated camphene, and a mixture of DDT with hexaethyl tetraphosphate, but additional studies are necessary to show the effectiveness of these treatments as compared with such treatments as benzene hexachloride and the mixture of DDT and nicotine sulfate.

The reduction in thrips populations and the numbers of surviving thrips are not very closely correlated with yields. Great variations in thrips infestation between plants lessen the value of population counts as an index of the effectiveness of insecticidal treatments when dealing with so variable and unstable an insect. It is possible that some of the insecticides or auxiliary materials may have directly

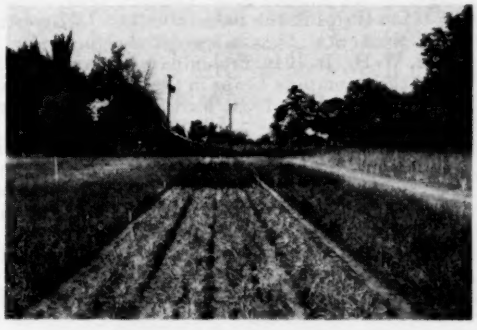

FIG. 5.—Experimental plots on the control of the onion thrips at Twin Falls, Idaho, August 11, 1946. The center plot in the foreground was not sprayed whereas the one on the left received 5 applications of DDT-toluene emulsion and the one on the right 5 applications of tartar emetic spray.

affected the growth of the onion plant but this was not in evidence and will have to be studied in later experiments. Finally, for several years preceding 1945 beets were grown in the field where these experiments were conducted. These beets were grown in small plots with 30-foot fallow strips between plots. The resulting unevenness in soil fertility may have affected yields of onions.

It will be noted that the insecticide applications were very heavy. For example, in 1946 as much as 14 pounds of DDT per acre was applied to the crop. Although this rate is high, it should be recognized that in fields where the 14 to 20-inch rows are used, there are 31,080 feet of row per acre as compared with 17,650 feet of row per acre for other crops grown in rows 30 inches wide, where 150

gallons of spray is frequently necessary to obtain a thorough coverage of all parts of the plants.

SUMMARY.—Experiments were conducted at Twin Falls, Idaho, in 1945, 1946, and 1947 on the control of the onion thrips on bulb onions with different insecticides. Outstanding increases in yield were obtained with a spray containing DDT and nicotine sulfate. At the strengths tested this spray was superior to nicotine sulfate, DDT, or tartar emetic. Promising results were obtained with benzene hexachloride, chlordan, chlorinated camphene, and a mixture of DDT and hexaethyl tetraphosphate. The methoxy analog of DDT was relatively ineffective.—9-11-48.

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ENTOMOLOGY-PLANT PATHOLOGY SEMINAR AT UNIVERSITY OF DELAWARE

We are advised by Dr. L. A. Stearns of a seminar on the "Effect of Climate on Insects and Disease Attacking Crops," for agricultural students majoring in entomology and plant pathology. Supporting the students' work are numerous outside lecturers who will cover the following subjects.

Feb. 16—"Soil Treatments as Affected by Temperature and Moisture"; Mr. H. W. Ridgway, of Innis, Speiden & Co., Philadelphia, Pa.

23—"Climate and Crops"; Dr. C. W. Thornthwaite, Climatologist, Johns Hopkins University, Baltimore, Md.

March 2—"Weather"; Mr. G. C. Anderson, Meteorologist, New Castle Airport, New Castle, Del.

23—"Treatments for Wood, Paper, and Paint"; Dr. R. L. Krause, in Charge of Research on Industrial Fungicides, Pest Control Research Section, Grasselli Chemicals Dept., duPont Company, Wilmington, Del.

April 6—"Insect Development under Controlled Environmental Conditions"; Dr. R. E. Heal, Research and Development Div., Merck & Co., Inc., Rahway, N. J.

27—"The Pesticide Field in South America"; Mr. Frank Rapp, Sales Supervisor, Naval Stores Dept., Hercules Powder Company, Wilmington, Del.

May 4—"Weathering of Emulsifiers, Spreaders and Stickers"; Mr. J. V. Miller, Mgr., Insecticide Dept., Atlas Powder Co., Wilmington, Del.

11—"Sanitary Chemicals in Agriculture and in Industry"; Dr. F. O. Haas, Mgr., Sanitary Div. of Agricultural & Sanitary Chemicals Dept., Rohm & Haas Co., Philadelphia, Pa.

18—"Use of Insecticides and Fungicides under Different Climatic Conditions"; Dr. W. H. Tisdale, Mgr., Pest Control Research Section, Grasselli Chemicals Dept., duPont Company, Wilmington, Del.

The courses are proving to be very popular and are attended by representatives of many other departments on the campus.

Control of Turnip Aphids

GEORGE P. WENE, *Texas Agricultural Experiment Station, Weslaco*

The turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis), is one of the major insect pests of leafy vegetables in the Lower Rio Grande Valley. Heavy infestations can ruin fields of turnips, radishes and mustard greens in a short time. Light infestations of aphids have been the principle reason for the rejection of turnip and mustard greens grown for fresh market and canning purposes.

A review of the literature shows that very little control work has been done on this insect recently. Hull (1929) obtained from 44 to 96 per cent control of this insect with a 1.0 per cent nicotine dust. Allen and Harrison (1941) recommended from 3 to 6 applications of either a 3.0 per cent nicotine dust or a 1.0 per cent rotenone dust. Isely & Miner (1946) obtained very good control of the turnip aphid with a dust containing 0.75 per cent gamma benzene hexachloride. Brooks & Anderson (1947) in laboratory tests found that 1 per cent gamma benzene hexachloride dust gave significantly better control of turnip aphids than did a 3.0 per cent nicotine dust. Since the beginning of the last war, growers in this area have been using a 0.1 per cent impregnated pyrethrum dust with very little success. Creighton & Gresham (1947) found that a 1.0 per cent parathion dust gave 100 per cent control of *Myzus persicae* (Sulz.) on shade-grown tobacco.

MATERIAL AND METHODS.—In experiment 1, shown in table 1, the plots were one-fiftieth of an acre in size and arranged into randomized blocks. Each treatment was replicated four times. The treatments were as follows: 1.0 per cent gamma benzene hexachloride; 0.25 per cent parathion; 1.0 per cent parathion; 0.1 per cent pyrethrins; a dust mixture containing 0.04 per cent pyrethrins, 0.5 per cent rotenone and 0.5 per cent piperonyl cyclohexenone; 3.0 per cent nicotine; and check or untreated. All insecticides were applied early in the morning with rotary hand dusters at approximately 30 pounds per acre. The turnips in this experiment were sown in rows spaced 8 inches apart. Due to the high soil salinity and lack of soil moisture these plants, 3 to 4 inches in height, showed little or no growth during the course of the experiment.

The plots were 0.02 acre in size in experiment 2, shown in table 2, and arranged randomized blocks. Each treatment was replicated four times. The treatments were as follows: 0.1 per cent pyrethrins (impregnated); 0.04 per cent pyrethrins with 0.5 per cent piperonyl cyclohexenone; 0.1 per cent pyrethrins with 1.0 per cent DDT; 3.0 per cent nicotine; and check or untreated. All insecticides were applied early in the morning with rotary hand dusters at approximately 30 pounds per acre. The turnips in this field were sown in rows spaced 8 inches apart. The plants were only 3 to 4 inches in height and showed very little growth during the experiment because of high soil salinity

Table 1.—Effectiveness of various insecticides in the field against the turnip aphid.

TREATMENTS	APHID POPULATION PER LEAF AT FOLLOWING DAYS AFTER DUSTING									
	1		3		7		10		14	
	Number	Per Cent Control	Number	Per Cent Control	Number	Per Cent Control	Number	Per Cent Control	Number	Per Cent Control
1% Gamma benzene hexachloride	1.5	94.7	0.4	98.8	1.2	98.5	0.5	99.2	2.6	96.3
0.25% Parathion	0.3	98.9	0.2	99.4	0.9	98.6	10.6	82.9	13.4	80.7
1% Parathion	0.0	100.0	0.0	100.0	0.5	99.3	1.8	97.0	6.1	91.2
3% Nicotine	4.5	84.0	3.4	89.4	21.1	69.0	23.4	61.1	34.9	49.8
0.1% Pyrethrins (impregnated)	22.5	19.9	19.8	38.3	34.0	50.1	37.0	38.4	49.1	29.3
0.04% Pyrethrins plus 0.5% Rotenone plus 0.5% Piperonyl cyclohexnone	37.3	0.0	16.7	48.0	16.1	76.3	28.8	52.1	32.5	53.2
Untreated	28.1	—	32.1	—	68.1	—	60.1	—	69.5	—
Least significant difference required at: 5% level	17.0		10.8		23.3		18.8		17.5	
1% level	23.3		14.7		23.0		25.9		24.0	

Table 2.—Effectiveness of various insecticides in the field against the turnip aphid.

Treatments	Aphid Population per Leaf at Following Days After Dusting					
	1		3		7	
	Number	Per Cent Control	Number	Per Cent Control	Number	Per Cent Control
0.1% Pyrethrins (impregnated)	35.4	27.2	31.3	84.1	73.1	0.0
0.04% Pyrethrins plus 0.5% piperonyl cyclohexenone	13.7	71.8	22.0	63.3	48.1	34.8
0.1% Pyrethrins plus 1% DDT (impregnated)	15.8	67.4	19.1	68.1	30.9	51.8
3% Nicotine	6.9	85.8	7.7	87.1	21.8	65.9
Untreated	48.5	—	59.9	—	64.1	—
Least significant difference required at: 5.0% level	21.2		32.2		24.1	
1.0% level	29.7				33.8	

Table 3.—Effectiveness of various insecticides in the field against the turnip aphid.

Treatments	Aphid Population per Leaflet at Following Days After Dusting					
	1		3		7	
	Number	Per Cent Control	Per Cent	Per Cent Control	Number	Per Cent Control
0.5% Gamma benzene hexachloride	56.0	60.1	40.5	63.8	52.8	67.3
1% Gamma benzene hexachloride	21.3	91.2	3.4	97.0	5.3	96.7
0.25% Parathion	22.9	83.7	6.0	94.6	35.2	79.4
1% Parathion	0.1	99.6	0.0	100.0	0.0	100.0
0.1% Pyrethrins plus 1.0% DDT (impregnated)	86.3	40.5	37.3	66.8	95.5	40.8
3% Nicotine	11.8	91.5	18.4	83.6	72.7	54.9
Untreated	140.5	—	111.9	—	161.4	—
Least significant difference required at: 5.0% level	29.6		17.8		66.2	
1.0% level	40.6		24.4		90.7	

and a lack of moisture.

In experiment 3, shown in table 3, the plots were 0.02 acre in size and arranged in randomized blocks. Each treatment was replicated four times. The treatments were as follows: 0.5 per cent gamma benzene hexachloride; 1.0 per cent gamma benzene hexachloride; 0.25 per cent parathion; 1.0 per cent parathion; 0.1 per cent pyrethrins with 1.0 per cent DDT; 3.0 per cent nicotine; and check or untreated. All treatments were applied early in the morning with rotary hand dusters at approximately 35 pounds per acre. The turnips in this field were sown in rows spaced 8 inches apart. The turnip leaves were approximately 12 inches in length, giving the field an appearance of one solid mass of turnip greens.

In experiment 4, shown in table 4, the plots were 0.014 acre in size and arranged in randomized blocks. Each treatment was replicated four times. The treatments were as follows: 0.5 per cent gamma benzene hexachloride; 1.0 per cent gamma benzene hexachloride; 0.25 per cent parathion; 1.0 per cent parathion; 0.1 per cent pyrethrins with 1.0 per cent DDT; 3.0 per cent nicotine; and check or untreated. All insecticides were applied early in the morning with rotary hand dusters at approximately 15 pounds per acre. In this experiment the aphid infestation was on radishes which were planted in plant beds spaced 3 feet apart. Approximately half the crop had been harvested and the remaining plants were heavily infested with aphids.

In Experiment 5, shown in table 5, the plots were 0.0166 acre in size and arranged in randomized blocks. Each treatment was replicated three times. The treatments were as follows: 0.5 per cent gamma benzene hexachloride; 1.0 per cent gamma benzene hexachloride; 0.25

Table 4.—Effectiveness of various insecticides in controlling turnip aphids on radishes.

Treatments	Ave. Aphids per Leaf at Following Days After Dusting		
	1	3	7
0.5% Gamma benzene hexachloride	48.8	42.1	20 8[1]
1% Gamma benzene hexachloride	30.9	12.9	8.1
0.25% Parathion	24.6	27.4	48.9[1]
1% Parathion	0.9	1.2	7.4
0.1% Pyrethrins plus 1.0% DDT (impregnated)	33.8	89.4	[2]
3% Nicotine	41.2	75.0	[2]
Untreated	110.3	118.6	[2]

[1] Plants dead in the fourth replicate.
[2] Plants dead.

Table 5.—Effectiveness of various insecticides in controlling turnip aphids on mustard greens.

Treatments	Aphid Population 48 Hours after Dusting	
	Number	Per Cent Control
00.5% Gamma benzene hexachloride	15.8	65.0
1% Gamma benzene hexachloride	1.6	96.4
0.25% Parathion	3.0	93.4
1% Parathion	0.0	100.0
3% Nicotine	0.1	99.8
Untreated	45.2	—

per cent parathion; 1.0 per cent parathion; 3.0 per cent nicotine; and check or untreated. All insecticides were applied early in the morning with rotary hand dusters at approximately 15 pounds per acre. In this experiment the aphid infestation was on mustard greens. These greens were approximately 15 inches in height and had been planted in rows spaced 3 feet apart.

In experiment 6, shown in table 6, the plots were 0.0166 acre in size and arranged in randomized blocks. Each treatment was replicated three times. The treatments were as follows: 1.0 per cent gamma benzene hexachloride; 1.0 per cent parathion; 3.0 per cent nicotine; and check or untreated. The insecticides were applied with rotary hand dusters early in the

Table 6.—Effectiveness of various insecticides in controlling turnip aphids during warm weather.

Treatments	Aphid Population 24 Hours after Dusting	
	Number	Per Cent Control
1% Gamma benzene hexachloride	1.1	97.4
1% Parathion	0.0	100.0
1% Nicotine	1.0	97.7
Untreated	42.8	—

morning. Due to a wind blowing about 15 miles per hour the rate of insecticide application was increased to 40 pounds per acre. The turnips in this experiment were about 12 inches in height and had been planted in rows 3 feet apart.

The treatments in the first four experiments were applied when the mean daily temperature varied between 52° and 64° F. This is typical of the growing season for mustard greens, turnips and radishes. The last two experiments were conducted at the end of the growing season when the mean daily temperature was 70° F. or above.

The efficiency of the various treatments was determined by selecting 10 leaves or leaflets at random from each plot at definite time intervals after the dust application and then counting the surviving aphids. The significance of the data in the first three experiments was determined by the analysis of variance.

RESULTS.—The data in the first three tables show that during the regular growing season of turnips in the Lower Rio Grande Valley a 3.0-per cent nicotine dust[1] greatly reduced the aphid population 3 days after the treatment application. This reduction was not sufficient to prevent the population from increasing greatly between the third and seventh day counts. Turnip and mustard greens must be practically aphid free if sold for either canning or fresh market purposes. One dusting of nicotine during the regular growing season will not reduce the population sufficiently to make the greens acceptable for market purposes, and the low dollar returns of these crops make repeated dusting prohibitive, especially since nicotine has such a short period of effectiveness. The data in tables 5 and 6 show that this 3 per cent nicotine dust is very effective in controlling turnip aphids when the mean daily temperature is 70° F. or over. This data indicates that the low temperature during the normal growing season, which varies between 52° and 64° F., is too low for obtaining the most effective use of nicotine. Isely & Miner (1946) also point out that low temperatures prevented the effectiveness of nicotine in controlling the spinach aphid, *Myzus persicae* (Sulz.).

The data in tables 1 and 2 show that an addition of 1-per cent DDT or 0.5-per cent piperonyl cyclohexenone increased the toxicity of an impregnated pyrethrum dust. Aphid population counts taken 1 and 3 days after treatment applications show that the 3-per cent nicotine dust was superior to an impregnated dust containing 0.1 per cent pyrethrins and 1.0 per cent DDT. However, there was no significant difference in the effectiveness of

[1] Made from "*Black Leaf 10 base.*"

these two materials 7 days after treatment applications. Although these mixtures of pyrethrins plus DDT or piperonyl cyclohexenone gave significant reductions in the aphid population, the reductions were not sufficient to prevent rapid re-infestation.

The data in the various tables show that benzene hexachloride, used at a 1-per cent gamma concentration, was very effective in controlling the turnip aphid. The data in table 1 show that this concentration gave very good protection to turnips from aphids for a period of two weeks during cool weather. The data also indicate that a 1-per cent gamma concentration of benzene hexachloride has a good residual effect when applied during the regular growing season. The data in tables 3, 4, and 5 show that 0.5-per cent gamma benzene hexachloride reduced the aphid population greatly, but this reduction was not large enough to give good commercial control. No odor or taste contamination was detected in turnip greens picked and cooked one week after a single application of benzene hexachloride. A single application of benzene hexachloride did not affect the taste of radishes harvested 1 week later.

The data in table 1 show that a 1-per cent parathion dust was very effective in controlling turnip aphids for a period of 14 days. Although, the aphid population showed a slight increase in numbers between the 10 and 14 day counts, the data indicate that this material had not lost much of its residual toxicity. That parathion may lose its residual toxicity is shown in the data on the 0.25-per cent dust concentration. Table 1 shows that the 0.25-per cent parathion dust lost its effectiveness about 10 days after application. Tables 3 and 4 also show that this low concentration of parathion was losing its toxicity within 7 days of application.

The data in table 4 show that radishes heavily infested with turnip aphids can be saved if dusted with either a 1-per cent gamma benzene hexachloride or 1-per cent parathion dust. Lower concentrations of these dusts, as well as 3 per cent nicotine and the pyrethrum-DDT dusts, were ineffective.

Strong winds are common in this area. The data in table 6 indicate that turnip aphids can be controlled in windy weather if 40 pounds per acre of an effective dust is applied with hand dusters.

SUMMARY.—Experiments on the turnip aphid, *Rhopalosiphum pseudobrassicae* (Davis), show that 1-per cent concentrations of either parathion or gamma benzene hexachloride dusts gave excellent control. A 0.5-per cent gamma benzene hexachloride did not give satisfactory control. A 0.25-per cent parathion dust gave good aphid control but did not have the residual effectiveness of the 1-per cent concentration. The data indicate that parathion in low concentrations loses its residual toxicity in 7 to 14 days.

A 3-per cent nicotine dust greatly reduced the aphid population for about 3 days, but the surviving aphids rapidly increased. The data indicate that the turnip growing season is too cool for obtaining the most effective use of a nicotine dust.

Additions of 1 per cent DDT and 0.5-per cent piperonyl cyclohexenone increased the toxicity of a 0.1-per cent pyrethrum dust. However, the control obtained was not good enough for commercial purposes. A mixture of 0.1 per cent pyrethrins and 1 per cent DDT was just about as effective as a 3-per cent nicotine dust 7 days after application.

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Biology and Control of the Seed-Corn Maggot on Beans in New York

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The seed corn maggot, *Hylemyia cilicrura* Rondani injures bean, pea and corn seedlings before the plants emerge, by tunneling into the cotyledons or by damaging the growing tip. It also attacks seedling melons, potato seed pieces, and a wide variety of other seedling plants.

The two years of work on the biology and control, summarized in this paper, is divided into three parts: (1) attempted controls with treated seed and soil, (2) possible flavor hazards in treated beans, (3) rearing techniques. Schwardt & Patel[1] made preliminary tests against the maggots with DDT and benzene hexachloride seed treatments, with negative results. Turner (1945) got unsatisfactory results using DDT and a fungicide[2] as a seed treatment. Huckett (1947) showed some improvement over checks when the seeds were dusted with the fungicide. The only recently published data on the biology of *Hylemyia cilicrura* is that of Reid (1940). However, Reid was unable to rear the flies through successive generations.

Methods and Materials for Control.—Plot sizes for the seed treatments and dust treatments varied in area from 100 to 600 square feet. Most of the experiments had at least four replicates. Except for one test each with white marrow and yellow wax beans, all the work was done with red kidney beans. A 5 per cent methyl cellulose solution was the adhesive used for sticking the toxicants to the seed. Six hundred and fifty cubic centimeters of the solution were poured on a bushel of beans, and thoroughly distributed by shoveling. The dust was then sprinkled on through a sieve and thorough coverage obtained by more shoveling. The toxicant is more uniformly distributed if the beans are treated in 20-pound lots. The dusts were

[1] Unpublished data.
[2] *Spergon.*

Table 1.—Summary of soil treatments against the seed corn maggot, *Hylemyia cilicrura*, on red kidney beans in Victor, New York.

Treatments and and Dusts	Lbs. Dust per Acre	No. Plants Counted	No. Injured Plants	Average Per Cent Injury	Control-Over Check
		May 27, 1948			
Benzene-hexachloride 3% gamma and 25% other isomers	132	1610	112	6	13%
Benzene hexachloride 3% gamma and 25% other isomers	66	1618	131	8	11
5% Chlordan	40	1726	182	10	9
5% Chlordan	80	1615	131	8	11
5% Toxaphene	40	1742	341	19	0
5% Toxaphene	80	1771	322	18	1
Untreated check	—	1653	322	19	—
		June 1, 1948			
Untreated check	—	1361	320	23.9	—
5% Toxaphene	40	1433	379	23.6	0.3
5% Toxaphene	80	1329	298	22.4	1.5
5% Chlordan	40	1569	248	15.8	8.1
5% Chlordan	80	1639	127	07.7	16.2
Benzene-hexachloride 3% gamma and 25% other isomers	33	1274	374	29.6	−5.7
5% DDT	80	1362	283	20.7	3.2
		August 10, 1948			
Untreated Check	—	1021	502	49.1	—
5% Chlordan	40	1034	433	41.8	7.3
5% Chlordan	80	1170	312	28.1	21.0
Benzene-hexachloride 3% gamma-Isotox	33	1042	317	30.4	18.7
Benzene-hexachloride 3% gamma-Isotox	66	1112	166	14.8	34.3

spread on the soil by shaking from a quart ice cream carton containing the required amount of dust for the plot. Equally spaced bands of dusts were distributed and redistributed over the plots by frequent recrossings. The dusts were further worked into the soil, before the beans were planted, with a garden cultivator or by the planter.

Most of the dusts used to treat the seeds were also used in the soil treatment tests. In the 1947 experiments with treated seed, two dusts were tried, a wettable benzene hexachloride powder containing 6 per cent of the gamma isomer and 44 per cent of the other isomers, and a 50 per cent wettable DDT powder.

Seeds were coated with the benzene hexachloride at the rate of 4, 8 and 16 ounces per bushel, whereas the DDT was applied at 8, 16, and 24 ounces per bushel of seed.

In the 1948 experiments with treated seed, three dusts were tried, a 5 per cent wettable chlordan, a 5 per cent toxaphene, a 6 per cent benzene hexachloride[1] and a fungicide[2]—(tetrachloro-parabenzoquinone). The chlordan and toxaphene were used at one-fourth and one-half pounds per bushel of beans; the diluted benzene hexachloride 1 and 2 ounces per bushel, and the fungicide, at three ounces.

For the soil treatments, five dusts were tried, (1) two dosages of benzene hexachloride,–a 3 per cent gamma and a dust with a 3 per cent gamma isomer, plus 25 per cent other isomers; (2) 5 per cent wettable DDT; (3) 5 per cent toxaphene; (4) 5 per cent chlordan. Exclusive of the white marrow beans and the residual toxicity plots, all plots were dusted the day the beans were planted. The treated seed was prepared about three weeks before planting.

METHODS AND MATERIALS FOR REARING.—Two types of cages were selected for rearing the adults; (1) a glass cylinder 12 inches high and 4 inches in diameter, open at both ends; (2) a cylindrical copper wire cage 15 inches high and 6 inches in diameter. The glass cylinders were covered at the top with three thicknesses of cheesecloth, and set in a dish or on a piece of board. The females oviposited in 2-inch salve cans filled with sterilized greenhouse soil or with sand. Three diets are being tested for the adults:

1. A 10 per cent buckwheat honey solution.
2. A 10 per cent buckwheat honey solution and moistened fish meal.
3. A 10 per cent buckwheat honey solution and chopped earthworms (from a compost pile).

The honey solution was placed in a small Comstock bottle with a cotton wick; a small amount of moistened fish meal (previously prepared and kept in the refrigerator) was placed in the oviposition can, as were the chopped earthworms. The old food was replaced every third day or sooner. Salve cans were checked every day for the eggs. If the eggs were found, the contents of the can were dumped into a sieve and sifted into a flat "shuttlebox." The sifted soil was then shuttled back and forth to expose the eggs. These eggs were brushed into small pieces of green blotting paper and placed in a jelly dish or wide-mouth quart jar, together with the larval food and some sterilized greenhouse soil. No satisfactory medium for large scale rearing has been formulated, but in the media listed below from 30 to 95 per cent of the larvae in

Table 2.—Summary of the residual toxicity of dusts applied to the soil as a control for the seed corn maggot, *Hylemyia cilicrura*, on red kidney beans in New York. (Planted September 7, 1948) Dusted August 10, 1948.)

TREATMENT	LBS. DUST PER ACRE	NO. PLANTS COUNTED	NO. INJURED PLANTS	INJURY	CONTROL OVER CHECK
Untreated check	—	931	175	18.7%	—
5% Chlordan	40	948	36	3.6	15.1%
5% Chlordan	80	952	37	3.9	14.8
Benzene-hexachloride 3% gamma-Isotox	33	665	126	18.9	0
Benzene-hexachloride 3% gamma-Isotox	66	719	105	14.5	4.2

[1] Based on *Isotox*.
[2] *Spergon*.

some of the replicates of each diet pupated.

1. Presoaked dogfood[1] and stringbeans (entire pod).
2. Mixture equal parts of dogfood and fish meal (very moist and prepared in advance).
3. Dogfood, bran, fishmeal, oathulls equal parts plus a half-cake of yeast, a tablespoon of malt, about 500 cc of water per 400 gms. of the mixture.
4. Alfalfa meal, oathulls, fishmeal one part each, bran 2 parts plus a half-cake of yeast, a tablespoon of malt, about 500 cc. water per 400 gms. of the mixture.

Larvae developed and pupated at temperatures ranging from 54° to 77° F. Pupae were placed in jelly dishes containing moistened sand. When the puparia began to darken, they were placed in vials, three pupae to a vial. This transfer to the vials is necessary, inasmuch as the females can be easily distinguished from the males when they are transferred to the cages.

RESULTS FROM THE CONTROL WORK.—Data from the treated seed plots is still too preliminary for use in recommendations for control. Of the dusts tested as soil treatments, benzene hexachloride and chlordan gave consistent control over the checks; however, benzene hexachloride at 132 pounds per acre offered no better control than the medium dosage of 66 pounds per acre. Even the lower dosage when carefully dusted, worked into the soil, and applied near enough to planting time, offered good control, as table 1 shows. Nevertheless, their use may be restricted, due to the flavor imparted to the dried beans. Table 4 shows that the benzene hexachloride did not impart a strong flavor in the fresh yellow wax beans. The tests for residual toxicity of these dusts prove that the toxicity of benzene hexachloride is significantly reduced in approximately a month. In contrast, the chlordan dust was consistently better than the check, even when applied one month before planting. Beans grown in chlordan-treated soil apparently do not develop detectable off-flavors or odors. If analytical work now in progress shows that chlordan is not absorbed, then it may become recommendable for maggot control.

Table 3.—A summary of flavor and odor tests on red kidney beans grown on soils treated with the following dusts.

Dust Used and	Lbs. per Acre	People Detecting Odor			People Detecting Flavor		
		Nat.	Weak Mod.	Strong	Nat.	Weak Mod.	Strong
	(Victor, New York)						
Benzene-hexachloride 3% gamma and 25% other isomers	132	5	5	6	1	13	2
Benzene-hexachloride 3% gamma and 25% other isomers	66	3	9	4	4	9	3
5% Chlordan	80	13	2	1	15	1	0
5% Chlordan	40	13	2	1	12	4	0
5% Toxaphene	80	15	0	1	16	0	0
Untreated check	—	15	0	1	16	0	0
	(Flint, New York)						
5% Chlordan	80	12	0	0	7	5*	0
5% Chlordan	80	12	0	0	9	3	0
Benzene-hexachloride 3% gamma Isotox	33	8	2	2	7	5	0
Untreated check	—	10	2	0	11	1	0

* Weak.

REARING RESULTS.—Seed-corn maggot adults will mate and oviposit in the laboratory if the buckwheat honey solution is supplemented by the fish meal or chopped earthworms, and if the flies are kept in the glass cylinders described. As this paper is being written, the F2 generation is ovipositing. As many as 150 fertile eggs per female can be expected. However, the average for the F1 females was about 50 eggs. The preoviposition period in the

[1] Gaines.

Table 4.—A summary of flavor and odor tests on yellow wax beans grown on soils treated with the following dusts. (Ithaca, New York).

Dust Used and	Lbs. per Acre	People Detecting Odor			People Detecting Flavor		
		Nat.	Weak Mod.	Strong	Nat.	Weak Mod.	Strong
5% Chlordan	80	13	1	0	10	4	0
Benzene-hexachloride 3% gamma-Isotox	33	12	2	0	9	5	0
Benzene-hexachloride 3% gamma-Isotox	66	10	4	0	9	5	0
Untreated check	—	14	0	0	9	5*	0

* Weak.

F1 generation, fed upon honey and meal or honey and worms, ranged from 11 to 30 days; whereas in the F2 generation, 9 to 16 days was the range, with a higher frequency around thirteen days. These data are from cages where the daylight greenhouse temperature was not carefully controlled. Between 10 A.M. and 3 P.M., the temperature was as high as 90°F., but for the remainder of the 24 hour period, it remained at 70°, plus or minus 3.

SUMMARY.—Seed treatment gives little promise as a control measure for the seed corn maggot. Chlordan and benzene hexachloride dusts used as soil treatments reduced maggot injury, however, the benzene hexachloride had a limited residual toxicity usefulness. Both insecticides imparted a flavor to dried beans; however the chlordan flavor was not detected consistently by the tasters. Seed corn maggot adults will mate and oviposit in the laboratory if the buckwheat honey solution is supplemented with moistened fish meal or chopped earthworms; and if the adults are kept in the cages described.

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NEW MEMBERS AS OF APRIL 5, 1949

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Loss in Yield of Dent Corn Infested with the August Generation of the European Corn Borer[1]

H. O. Deay, *Purdue Agr. Expt. Sta., Lafayette, Ind.*, L. H. Patch, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*, and R. O. Snelling, *formerly of U.S.D.A., Agr. Res. Adm., Bureau of Plant Industry, Soils, and Agricultural Engineering*

Most of the studies on the resistance of dent corn to the European corn borer, *Pyrausta nubilalis* (Hbn.), have concerned themselves with the numbers of larvae maturing in different inbred lines and hybrids from given numbers of eggs placed on the strains by hand. Patch *et al.* (1942, 1945) have published the results obtained with the single-generation strain of the borer which hatches in late June and early July.

Other studies on resistance have included measurements of the ability of different hybrids to withstand breakage under given infestation of the second generation of the multiple-generation strain of borers—*i.e.*, to tolerate the borer. One such study of a group of hybrids showed that, as the breakage below the ear in the absence of borers increased from 0.2 to 25.0 per cent of the stalks, the additional breakage caused by each additional borer in the stalk below the ear increased by linear regression from 2.30 to 11.55 per cent.[2] One of these hybrids showed the possibility of having some tolerance because breakage due to additional borers did not increase as rapidly as predicted.

Studies by Patch and others (1942) on the single-generation borer in Ohio have considered borer tolerance in the sense that after the proper discounts have been made for differences in yield due to other causes one hybrid outyields another hybrid under an equal infestation of borers. The rates at which the bushel yields of shelled corn by different hybrids were reduced by each additional borer per plant were calculated in 149 tests. In only four of these tests, two of which were on the hybrid Ill. A × Ind. TR, were reductions found to be significantly less than those predicted on the basis of regression on yield in the absence of borers. The yield of this hybrid should have been reduced 3.67 bushels per acre for each additional borer per plant had it reacted according to prediction. Actually its yield was reduced an average of 2.35 bushels per borer per plant. Apparently a few hybrids are able to maintain their yields in the presence of borers to a greater degree than other hybrids of equal yielding capacity.

It is the purpose of this paper to present data obtained in 1944–1946 on the loss in yield under artificial infestation in August coincidental with the second generation of the multiple-generation strain of the corn borer, and to point out one inbred line that in single-cross hybrids has the ability to maintain yields under borer infestation better than four other lines.

Loss of Yield in 1944.—Sixteen single-cross hybrids were compared in a planting made May 28, 1944, near Lafayette, Indiana. Seven-fold replicated plots of six six-hill rows were used. The three-plant hills were 40 inches apart each way. The date of silking was recorded on a tag attached to the plants when silks began to show. Rows numbered 1 and 2 were subjected to natural infestation only, rows 3 and 4 had three egg masses placed on each plant in addition to the natural infestation, and rows 5 and 6 received six egg masses per plant. The egg masses were obtained in quantity from moths reared in the laboratory. By this method small disks of waxed paper each bearing an egg mass are pinned on the plants just before the eggs hatch. The eggs hatched from August 4 to August 11 or an average of 3 days after the hybrids began to show silks near the peak of natural infestation on August 10.

Beginning the second week in September single plants were taken from rows 1, 3, and 5 from each plot of each hybrid and dissected to determine the number and size of borers surviving and their location in the plants. The second time over the plots rows 2, 4, and 6 were sampled. This alternation in taking the samples was repeated until the eighth sample was dissected on October 5. Since newly hatched larvae are sometimes blown by the wind

[1] Purdue University Agr. Expt. Station Journal Paper No. 370.

[2] Stalk Breakage of Dent Corn Infested with the August Generation of the European Corn Borer, by L. H. Patch, H. O. Deay, and R. O. Snelling. (Unpublished Manuscript).

to adjacent hills, fewer borers were found in plants from row 1 than row 2 and from row 3 than row 4. This was so because row 1 in a plot was always next to row 1 in an adjacent plot and hence was farther away than row 2 from the rows receiving 3 additional egg masses. Also row 3 was farther away than row 4 from the rows receiving 6 masses.

yields at each borer level were determined from the total number of plants remaining in the seven replications after the samples had been taken to determine borer populations. This total varied from 84 to 96 plants according to the hybrid. Yields were put into terms of bushels per acre, of shelled corn containing 15.5 per cent moisture. The naturally infested rows 1

Table 1.—Reduction in yield of shelled corn of single-cross hybrids by August generation of the European corn borer, Lafayette, Ind., 1944.

Single-Cross Hybrid	Mean Number of Borers per Plant ($\bar{X}$)	Mean Bushels per Acre in Presence of Borers ($\bar{Y}$)	Bushels per Acre in Absence of Borers on Basis of $\bar{X}$, $\bar{Y}$ and B (A)	Reduction in Bushels per Acre by Each Additional Borer per Plant: On Basis of Regression of Y and X (B)	Reduction in Bushels per Acre by Each Additional Borer per Plant: On Basis of Regression of B and A (B′)	Days After July 31 When Plants Silked
Ind. Pa×Ia. L317	6.57	72.9	88.5±2.76	2.40±.364	2.13	6.7
Ind. P8×Ia. L304A	6.88	77.2	87.8±2.68	1.53±.333	2.10	3.0
Ind. TR×Ill. Hy	9.56	56.5	80.0±2.80	2.46±.254	1.80	3.6
Ind. P8×Ill. R4	7.41	59.3	73.6±2.96	1.93±.352	1.56	4.6
Ind. P8×Kan. K230	8.05	62.6	70.7±2.82	1.02±.306	1.45	4.0
Ill. R4×Ia. L317	6.75	57.7	65.4±3.00	1.15±.394	1.25	4.4
Ind. WF9×Ind. P8	6.37	58.8	63.0±1.65	0.69±.224	1.15	2.9
Ind. WF9×Ia. L317	6.31	57.3	62.8±1.61	0.87±.219	1.15	4.0
Ill. A×C.I. 187–2	8.26	52.3	57.4±1.61	0.64±.167	.94	3.9
Ind. WF9×Kan. K230	6.05	47.9	57.3±1.79	1.58±.262	.94	0.9
Ia. PR×Ind. 38–11	8.86	48.3	56.8±1.60	0.95±.155	.92	7.3
Ill. R4×Kan. K230	6.00	49.8	54.5±1.77	0.80±.262	.83	4.0
Ind. WF9×Ill. A	6.06	47.5	54.2±1.70	1.13±.245	.82	0.9
Ind. WF9×C.I. 187–2	7.62	48.9	53.6±1.57	0.62±.174	.80	3.6
C.I. 187–2×Ill. R4	6.65	43.1	47.3±1.77	0.63±.236	.55	3.9
Ind. WF9×Ill. R4	6.04	42.3	45.8±1.57	0.50±.221	.50	2.3
Mean	7.09	55.2	63.7±0.55	1.18±.069	1.18	3.8

A preliminary analysis of the data showed that the three persons dissecting the plants were about equally expert in finding all the borers, and that the size and location of the borers were about the same in the plants receiving the additional egg masses by hand as in the plants that received natural infestation only. An examination of the field in early July showed a very low natural infestation by the first generation of moths, hence the natural infestation in rows 1 and 2 was almost wholly caused by the August generation of moths, and differences in yield between hybrids were due almost entirely to differences in degree of infestation by that generation.

The ears were harvested during the period from October 13 to 18, and the

and 2 for all hybrids averaged 62.0 bushels per acre, a yield somewhat below the average yield for other years.

The linear regression (B) for each hybrid of the yield per acre (Y) on number of borers per plant (X) was calculated by using the six pairs of data available from rows 1 to 6. In calculating this regression the number of borers in the entire plant on September 9 was used because many of the larvae disappeared from the plants after September 9 and even small larvae feeding on the leaves are known to cause material reduction in yield. The number of borers per plant on September 9 was estimated for each borer level of each hybrid on the basis of the regression of number of borers per plant on date of plant dissection. Yields in the absence of borers

(A) were calculated on the basis of the regression coefficients (B), the mean numbers of borers per plant ($\overline{X}$), and the mean yields ($\overline{Y}$). The regression of B on A was calculated in order to determine in what way loss in yield in the presence of borers might be associated with yield in the absence of borers. The values of B′ were calculated on the basis of regression on B on A. Table 1 gives these estimates and the standard errors of A and B.

the corresponding reductions in yield caused by each additional borer varied from 2.13 to 0.50 bushels, or from 2.41 to 1.09 per cent. These percentages when compared with 1.85, the expected percentage, show that the yield of the higher yielding hybrids were reduced more than expected. The same phenomenon has been observed in numerous other experiments. The greater loss suffered by the high yielding hybrids was not enough to offset the

Table 2.—Differences in yield of single-cross hybrid dent corn between hills infested naturally with about 0.9 European corn borer per plant and hills averaging agout 9.0 borers per plant from additional hand infestation in August, Lafayette, Indiana, 1945. Averages of supplementary data are given also.

	Inbred Lines as Common Parents	Differences in Yield-Bushels per Acre				
		Inbred Lines Compared in Single-Cross Combination				
		Ind. WF9	Ind. WF9A	Ind. P8	Ill. Hy.	Ia. L317
Supplementary Data (Means are for same groups of hybrids as the means of differences in yield)	Ill. Hy.	15.2	20.2	14.5		
	Ind. 38-11	13.8	12.6	5.5	29.2	23.0
	Ind. B2	21.5	6.2	15.1	26.2	23.1
	Ind. WF9			7.9	15.2	30.6
	Ind. WF9A			13.0	20.2	23.3
	Mean	16.8	13.0	11.7		
				10.4	22.7	25.0
Bushels per Acre Yield of Hills Infested Naturally	Mean	83.6	85.5	82.7		
				84.1	86.4	84.9
Borers per Plant in Hills with Additional Eggs	Mean	10.42	7.75	9.17		
				9.25	10.13	8.06
Days after July 31 when Hybrids Silked	Mean	7.4	8.9	11.1		
				9.7	9.5	11.4

The average yield of all 16 hybrids was plotted on cross section paper against the average number of borers per plant in each of the six rows. The plotted points deviated by less than a bushel from a straight line fitted to them. It thus appeared that the yield of shelled corn decreased by linear regression from 62.0 to 50.0 bushels per acre as the number of borers per plant increased from 1.35 to 11.49 or the reduction in yield was at the rate of $1.18 \pm .069$ bushels per acre per borer per plant. In the absence of borers it is estimated the average yield would have been 63.7 bushels per acre. The yield was reduced, therefore, 1.85 per cent per borer per plant.

The values of A in table 1 show that the estimated yields in the absence of borers varied with the hybrid from 88.5 to 45.8 bushels and values of B′ show that advantage in yielding ability they had over the low yielding hybrids, for under an infestation of 10 borers per plant the respective yields would have averaged about 67.2 and 40.8 bushels per acre.

Five hybrids had line Ind. P8 as one of the parents (Table 1). The three hybrids having Ia. L304A, Kan. K230 and Ind. WF9 crossed on P8 had their yields reduced an average of $1.08 \pm .168$ bushels per acre per borer per plant compared with 1.57, the predicted average. Taking into consideration the standard errors of B′ not given in table 1, the difference of $0.49 \pm .188$ bushel is significant with odds of at least 49 to 1. On the other hand the reductions in yield of P8×R4 and P8×L317 were more, but not significantly more, than the predicted amounts.

LOSS OF YIELD IN 1945.—The favorable performance of the P8-hybrids in 1944

was repeated in another experiment conducted in 1945 when Indiana inbred lines P8, WF9, and WF9A were compared with each other in single-cross combinations on common parents and lines P8, Ill. Hy, and Ia. L317 were compared with each other in the same way. Thirty hybrids were planted May 25 in 10-hill, 4-fold replicated plots with three plants per hill. Five hills in each plot were infested naturally with an average of 0.93 borer per plant and 5 hills receiving 6 additional egg masses per plant by hand between August 6 and 13 averaged 9.04 borers per plant. The 19 hybrids considered in this study silked between August 6 and 13. The data, including average yields under natural infestation and the difference between yields under natural and hand infestations, are given in table 2.

Table 2 shows that the yields of the groups of P8- hybrids were reduced less by the borer than those of the other groups. The P8- hybrids, silking August 11, had their yields reduced 11.7 bushels by 9.2 borers per plant or 1.27 bushels per borer whereas the WF9- hybrids, silking August 7, had their yields reduced 16.8 bushels by 10.4 borers per plant or 1.62 bushels per borer. The difference of 1.2 borers is not significant. If the WF9- hybrids had silked 4 days later, at the same time as the P8- hybrids, it is probable their yield reduction would have been greater than 16.8 bushels. Since the two groups showed about the same yielding ability (82.7 versus 83.6 bushels) the comparison is not affected because of level of yield.

Another group of P8-hybrids had its yield reduced 10.4 bushels or about 1.11 bushels per borer compared with 22.7 and 25.0 bushels or about 2.25 and 3.09 bushels per borer for the Hy- and L317-hybrid groups, respectively. The differences in yielding ability, in number of borers per plant, and in dates of silking are so small that they could not have had much effect on the comparisons. From these considerations it appears that in the 1945 as well as in the 1944 experiment the group of P8-hybrids possessed an inherent ability to maintain yield in spite of the borers to a greater extent than the groups of WF9-, Hy-, and L317-hybrids. The poor performance of the L317-hybrids in 1945 may explain the more-than-predicted loss in yield of hybrid P8×L317 in 1944.

Twenty-four of the 30 hybrids planted on May 25, 1945, were studied with respect to the effect that level of yield and date of silking had on the percentage reduction in yield. The P8-group of hybrids and hybrid WF9A×B2 in table 2 were not included. First, the regression of the yield from the hills infested by hand on the yield from the hills infested naturally was calculated. The yields were averages of the 4 replications. The yield from the hills infested by hand was predicted on the basis of this regression for each hybrid. Six groups of 4 hybrids each were made according to the yield of the hybrids under natural infestation. Then the average yields under natural and hand infestations the average number of borers per plant from both methods of infestation, and the average date of silking were determined for each group. Also the yield in the absence of borers was estimated by plotting those yields against the numbers of borers per plant and extending to zero borers the line that passed through the plotted points. With these data at hand the reduction in yield in bushels per acre per borer per plant and the reduction in yield as a percentage of the estimated yield in absence of borers were calculated. Similarly data were obtained for 6 groups made up from 26 double-cross hybrids grown in the same field in 2×10-hill, 4-fold replicated plots planted about the same time as the single crosses. The data from both lots of hybrids are given in table 3.

Table 3 shows that the estimated yield in the absence of borers and the reduction in yield as a per cent of this yield of group 1 of the single crosses are nearly equal to those values of group 1 of the double crosses. Also, the respective values of group 2 of the single crosses are nearly equal to those of group 2 of the double crosses and those of group 5 of the single crosses are nearly equal to those of group 3 of the double crosses. In fact, with the exception of group 6 of the single crosses, the plotted points of the 12 groups fall closely around the regression line of per cent reduction in yield on estimated yield in absence of borers. Hence the single- and double-cross hybrid groups were considered as one set in calculating the regression of per cent reduction in yield on estimated yield in absence of borers. Leaving out

group 6 of the single crosses. The per cent reduction in yield increased by linear regression from 1.37 to 3.93 per borer per plant as the estimated yield in the absence of borers increased from 66.8 to 92.9 bushels per acre. Including group 6 the percentages become 1.66 and 3.85, respectively. The last column in table 3 shows that date of silking varied little from group to group and hence could have had little effect on the above percentages.

—Another experiment planted May 24, 1945, included 45 late white single-cross hybrids in single row plots. Half of the plants in each plot were infested by hand with six egg masses per plant and the other plants became infested with an average of 2.5 borers per plant from natural infestation. Three groups of 15 hybrids were made according to the date of silking. The mean number of borers per plant and an estimate of the reduction in yield caused

Table 3.—Percentages of reduction in yield of dent corn single-cross and double-cross hybrids by the August generation of the European corn borer when the hybrids are grouped according to their yielding ability, Lafayette, Indiana, 1945.

Group No.	Estimated Yield		Borers Causing Reduction in Yield	Reduction in Yield		Days After July 31 When Plants Silked
	In Absence of Borers	Under Hand Infestation		Per Borer per Plant	As a Per Cent of Yield in Absence of Borers	
	Bushels per Acre	*Bushels per Acre*	*Number per Plant*	*Bushels per Acre*	*Per Cent*	*Number*
			Single-Cross Hybrids			
1	92.9	65.1	7.48	3.72	4.00	8.7
2	89.6	63.5	8.78	2.97	3.31	9.3
3	87.0	61.8	7.90	3.19	3.67	9.3
4	84.1	60.5	9.65	2.45	2.91	11.7
5	81.0	58.8	10.43	2.13	2.63	9.0
6	67.8	51.0	10.03	1.67	2.46	9.7
			Double-Cross Hybrids			
1	90.6	66.8	6.53	3.64	4.02	10.9
2	89.4	68.7	6.89	3.00	3.36	10.4
3	80.0	65.4	6.78	2.15	2.69	11.4
4	74.6	63.6	7.01	1.57	2.10	10.1
5	71.0	61.5	6.86	1.38	1.94	10.3
6	66.8	60.5	7.09	0.89	1.33	10.8

With the use of the same method as before, 6 groups of 4 single-cross hybrids each were made up according to their date of silking and the data calculated. The per cent reduction in yield increased by linear regression from 2.76 to 3.54 per borer per plant as the date of silking increased from 6.4 to 12.8 days after July 31. Although the regression is positive, as expected, it is not statistically significant with a t-value of only 1.79 for the 4 degrees of freedom available. The range in silking date among the double crosses was not great enough to permit a similar study, 22 of the 26 hybrids silking within 3 days.

OTHER EXPERIMENTS IN 1945 AND 1946.

by borers in each group are given in table 4.

In 1945 and 1946 several plantings of double-cross hybrid Ind. 610B with pedigree (WF9×Hy) (A×L) were made with 6-fold replication in plots containing 8 rows of 12 hills or 36 plants. The 6 inside rows were used. Three rows of the May 30, 1945, planting were infested naturally with 1.83 borers per plant and on the other three rows, in addition to the natural infestation, varying numbers of egg masses were put on by hand in late June to coincide with the first generation of the multiple-generation strain and again on August 10 to coincide with the second generation of that strain. Plant dissections

were made on July 23 to 25 to count the borers before they had pupated, again on August 8 to 10 to determine the number that did not pupate, and again on September 11 and 12 and October 2 to 4 to count both generations of borers. It was determined that 36.3 per cent of the borers came from June eggs and 63.7 per cent from eggs put on in August; and that most of the 79 per cent of the June borers which disappeared from the plants between July 25 and August 8 did not pupate.

the two experiments, hybrids with potential yields of 66.8 bushels per acre would have had their yields reduced 1.21 bushels per acre or 1.81 per cent per borer per plant and this reduction increased to 2.61 bushels or 2.95 per cent as the potential yield increased to 88.5 bushels per acre. The late white hybrids having potential yields of 68.5 and 83.5 bushels per acre in 1945 had those yields reduced 2.76 and 2.90 bushels per acre or 4.03 and 3.47 per cent per borer per plant.

Table 4.—Reduction in yield of shelled corn by August generation of the European corn borer Lafayette, Ind., 1945 and 1946.

Date of Planting	Hatching of Eggs with Reference to Silking of Plants	Estimated Yield		Borers Causing Reduction in Yield[1]	Reduction in Yield	
		In Absence of Borers	Under Hand Infestation		Per Borer Per Plant	As a Per Cent of Yield in Absence of Borers
		Bushels per Acre	*Bushels per Acre*	*Number per Plant*	*Bushels per Acre*	*Per Cent*
Late White Single-Cross Hybrids						
May 24, 1945	3 days before	83.5	59.1	8.4	2.90	3.47
May 24, 1945	5 days before	79.4	57.2	7.9	2.81	3.54
May 24, 1945	9 days before	68.5	47.8	7.5	2.76	4.03
Commercial Double-Cross Hybrid Ind. 610B						
May 30, 1945	3 days after[2]	118.6	101.2	10.3[2]	1.69±.277	1.42
June 11, 1945	4 days before	107.0	88.2	8.0	2.35±.326	2.20
May 21, 1946	2 days before	123.4	114.1	4.8	1.94±.377	1.57
May 31, 1946	6 days before	118.1	107.3	4.2	2.57±.323	2.18
June 10, 1946	12 days before	108.0	100.5	3.3	2.27±.700	2.10

[1] For hybrid Ind. 610B the number of borers is an average of three plots with varying numbers of borers per plant.
[2] Only 63.7 per cent of the borers were August generation and 36.3 per cent were June generation, most of which disappeared from the plants before they silked on August 7.

The other plantings of Ind. 610B were infested by hand with additional egg masses to coincide with the second generation of the multiple-generation strain. The borers found in the rows receiving additional eggs were almost wholly of the August generation. The mean number of borers per plant and the reduction in yield caused by the borers on each planting are given in table 4. The numbers of borers causing reduction in yield are averages of the rows receiving additional eggs.

DISCUSSION.—Potential yields in the absence of borers of 88.5 and 66.8 bushels per acre were common to the single- and double-cross hybrids of the 1944 and 1945 experiments. On the basis of the regression data already given and as an average of

In general, the hybrids having the eggs hatch earliest in the development of the plants suffered the greatest reduction in yield. Since the borers in these hybrids had a longer time to feed before the critical period of ear production and were larger, therefore during the period of ear production these late silking hybrids would be expected to suffer a greater reduction in yield from this cause alone.

It is emphasized that the use of the yield losses reported herein for estimating losses on the basis of country-wide survey data would underestimate the actual losses if the time the survey is made is not considered. During September and early October, while plants were being dissected to determine the borer population re-

ported herein, a pronounced decrease in the numbers of borers was observed, a decrease much more than the dead borers in the plants would indicate. For example, on September 9 an average of 10.1 borers per plant were found in the 16 single cross hybrids tested in 1944. Each day until September 26 an average of 2.10 ± 0.106 per cent of the borers disappeared, leaving 6.5 borers per plant on September 26. The losses in yield reported herein were determined on the basis of borer populations before many of the borers disappeared from the plants.

It should be noted also that the use of the yield losses for estimating losses on the basis of country-wide survey data would overestimate the actual losses if the borers mature later in the development of the corn than in the experiments reported herein. For example, in the locality of the 1945 experiments 50 per cent of the eggs laid by the moths in nature were laid by August 25. In the case of hybrid Ind.610B the eggs placed on the plants by hand hatched August 10. Ind. 610B probably suffered a greater reduction in yield per borer per plant than was suffered by the corn in farmers' fields.

SUMMARY.—Different plots of hybrid corn were infested by hand with varying numbers of corn borer egg masses to coincide with the natural infestation of the August generation of the multiple-generation strain of the corn borer. On the basis of the resulting different numbers of borers per plant the rates at which the yields were reduced and the potential yields in the absence of borers were estimated by regression methods. The rates were then expressed as percentages of the potential yields.

Single-cross hybrids with potential yields ranging from 45.8 to 88.5 bushels were tested in 1944 and another lot of single and double crosses with potential yields ranging from 66.8 to 92.9 bushels were tested in 1945. As an average of the two lots hybrids with potential yields of 66.8 bushels per acre lost 1.21 bushels or 1.81 per cent of their yield per borer per plant and this loss increased by linear regression to 2.61 bushels or 2.95 per cent as the potential yield increased to 88.5 bushels. Under an infestation of 10 borers per plant the 88.5-bushel hybrid would have outyielded the 66.8 bushel hybrid by 7.7 bushels.

In the 1944 experiment, three hybrids involving line Ind. P8 crossed on Ia. L304A, Kan. K230, and Ind. WF9 had their yields reduced an average of 1.08 bushels per acre by each additional borer per plant compared with 1.57 bushels, the predicted average. In 1945, three hybrids involving line P8 crossed on Ill. Hy, Ind. 38–11, and Ind. B2 had their yield reduced about 1.27 bushels per borer per plant compared with 1.62 bushels for hybrids involving line WF9 crossed on the same lines. Also, four hybrids with P8 crossed on 38–11, B2, WF9 and WF9A had their yield reduced about 1.11 bushels per borer per plant compared with 2.25 and 3.09 bushels for hybrids having Hy and Ia. L317, respectively crossed on the same lines. Evidently, line P8 is borer-tolerant in the sense that it has the ability to maintain yield in single-cross combination better than other lines.

In 1945, commercial hybrid Ind. 610B planted on May 30 and June 11 had its potential yield of 118.6 and 107.0 bushels per acre reduced 1.69 and 2.35 bushels or 1.42 and 2.20 per cent, respectively per borer per plant. In 1946, the same hybrid planted on May 21, 31, and June 10 had its potential yield of 123.4, 118.1 and 108.0 bushels per acre reduced 1.94, 2.57, and 2.27 bushels or 1.57, 2.18, and 2.10 per cent, respectively, per borer per plant.

In 1945, groups of late white single cross hybrids with potential yields of 68.5 and 83.5 bushels per acre had those yields reduced 2.76 and 2.90 bushels or 4.03 and 3.47 per cent, respectively. Since the larvae in these hybrids had a longer time to feed than in the other hybrids before the critical period of ear production they would be expected to suffer a greater reduction in yield than the other hybrids.

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Insecticidal Dust Formulations for Corn Borer Control

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The discovery (Annand *et al.* 1944) that DDT was highly effective against the European corn borer, *Pyrausta nubilalis* (Hbn), prompted many research workers to use this new insecticide against the borer. Experiments conducted during 1944 and 1945 revealed the fact that DDT was superior to the accepted corn borer insecticide, rotenone, but still left much to be desired. An attempt to increase the effectiveness of DDT dusts motivated the authors to formulate and test various DDT dust mixtures against the corn borer during the 1946, 1947, and 1948 seasons.

During the course of these experiments, many new insecticides were released for testing and certain of these were included in our experiments in hopes of finding a better corn borer insecticide than DDT.

Methods and Materials.—All of the experimental work was conducted at Rochelle, Illinois, on sweet corn grown for processing. The large acreage of sweet corn in the vicinity of Rochelle requires a planting season from the middle of May until the last of June. Such a sequence of plantings provides an opportunity to conduct experiments on both generations of corn borer. However, the dust comparisons made on the earliest company planted corn (Golden Cross) in 1946 and 1947 did not prove very successful because of the low borer populations. The authors made an earlier planting of four sweet corn varieties in 1947 in order to have a better test plot for certain comparisons. A first generation test was not attempted in 1948 because of the poor results obtained during the two previous years. Late June plantings of canning corn (88 day yellow) on the other hand, provided us with good experimental fields for the study of dust formulations.

Throughout these tests, a Niagara Even-Feed duster was used to apply materials. The 12 flexible tubes were arranged to have two nozzles over each of six rows. This dusting equipment was found to be ideally suited to experimental dusting because of its ability to deliver dust at a uniform rate across large size plots. The duster was mounted on a detasseling machine (Bigger *et al.* 1947). This high clearance carrier was necessary for second generation treatments on sweet corn 7 to 8 feet in height. One aerial dusting experiment is reported to show the superiority of parathion over DDT.

There was no standard plot design used. The two tests in 1946 and the second generation test in 1947 had duplicated plots ranging from 0.17 to 1.11 acres in size. The first generation test in 1947 consisted entirely of single block treatments, each block being 1.6 acres. In sampling the borer population from these experiments, at least four dissections were made in each treatment. The 1948 test, which consisted of 13 treatments, was a randomized block design with four replicates.

The 1947 evaluation of insecticides on four varieties of canning corn was a three-replicate design incorporating eleven buffer rows between the 6 row plots. Our experience during 1946 (Decker *et al.* 1947) indicated that untreated plots in a dust experiment failed to serve their purpose unless precautions were taken to eliminate or reduce contamination from drifting dust.

The formulations studied varied in diluents and additive materials rather than in the concentration of DDT itelf. Five per cent DDT was the concentration used except for the inclusion of one 10 per cent dust in the 1948 trials. From the many dust diluents on the market, the following were selected for comparison: Eastern magnesia talc, pyrophyllite, and clay.[3] Eastern magnesia talc was the common diluent used in the remaining 5 per cent DDT dusts. A non-volatile methyl-naphthalene solvent was added to DDT dusts at rates of 3, 5, and 10 per cent. In another dust, 3 per cent S.A.E. 10 oil was used in place of the methyl-naphthalene. To make the fifth impregnated dust a volatile solvent, methylene chloride, was employed to dissolve and impregnate 5 per cent DDT onto the talc carrier.

Four DDT dusts were formulated with dry supplemental materials in the hope

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Table 1.—Comparison of dust formulations for corn borer control.

DUST COMPOSITION	CORN BORERS PER				
	100 Plants				100 Ears
	1946		1947		1948
	1st Gen.	2nd Gen.	1st Gen.	2nd Gen.	2nd Gen.
	Test 1	Test 2	Test 3	Test 4	Test 5
5% DDT-Pyrophyllite	1.6	47.5	12.0	483	—
5% DDT-Attapulgus clay	—	—	8.0	322	33
5% DDT-Eastern magnesia talc	—	37.5	8.0	505	29
5% DDT-Talc-2% hemo-serum sticker	5.2	32.5	5.5	290	45
5% DDT-Talc-4% hemo-serum sticker	—	—	—	—	56
5% DDT-Talc-5% soy flour	6.7	47.5	10.0	343	33
5% DDT-Talc-20% sulphur	0.4	57.5	12.0	317	—
5% DDT-Talc-3% methyl-naphthalenes	—	—	6.5	498	57
5% DDT-Talc-5% methyl-naphthalenes	0.9	72.5	—	—	—
5% DDT-Talc 10% methyl-naphthalenes	4.5	175.0	—	—	—
5% DDT-Talc-3% S.A.E. 10 oil	—	—	12.5	337	44
5% DDT-Talc impregnated with volatile solvent	—	—	12.0	397	—
10% DDT-Talc	—	—	—	—	48
5% Methoxychlor	8.6	—	26.5	—	—
5% DDD	—	—	18.5	698	—
5% chlorinated camphene	—	—	13.0	613	—
1% Rotenone	—	—	11.0	553	—
40% *Ryania*	—	—	4.0	185	17
40% Impregnated *Ryania*	—	—	10.0	430	—
40% *Ryania*-4% hemo serum sticker	—	—	—	—	23
30% *Ryania*	—	—	—	—	32
20% *Ryania*	—	—	—	—	25
2% Parathion	—	—	—	—	22
Untreated Plots	12.4	315.0	—	—	—
Required difference at 5% level	—	53.3	—	134	Not. sig.
Number of applications	2	4	3	2	3
Rates of application per acre:					
Rotenone	—	—	25#	30#	—
Ryania	—	—	25#	30#	40#
Others	20#	20#	20#	20# 10% DDT	30# 15#

of enhancing the residual deposit of toxicant. One of these ingredients was a packing house byproduct called hemoserum, which was used at 2 per cent concentration. In 1948, the manufacturers of this product processed a hemo-serum sticker containing only one-half of the original material in an inert carrier. This latter product was used during the last season at 4 per cent strength, thus making it comparable to the original 2 per cent hemoserum addition used all three years.

The two remaining 5 per cent DDT dusts were processed with 5 per cent soy flour and 20 per cent conditioned dusting sulphur.

Three chlorinated hydrocarbons other than DDT were tried in certain of the tests. These included DDD, methoxychlor, and chlorinated camphene, all of which were used at 5 per cent concentration. A 1 per cent rotenone dust was included in the two 1947 experiments.

experiment are shown as footnotes in tables 1 and 2. In most of the early experiments, the dosage rate was held below what is commonly recommended so that control differences between dusts might be more apparent. Rates were raised to a more practical level during the 1948 test for the final evaluation.

RESULTS.—Three years testing of 5 per cent DDT formulated with various diluents and additive materials failed to show consistent differences between the dusts. The DDT dust blended with 2 per cent hemoserum showed some advantage in the second, third and fourth tests, but not in the first and fifth experiments (Table 1). The showing made by this dust in the fourth (second generation 1947) experiment should be given special consideration since this experiment had the highest borer population of the three years. The surviving population of corn borers after the use of 5 per cent DDT plus 2 per cen

Table 2.—Evaluation of three dusts on early planted canning corn, 1947.

Sweet Corn Variety	App. Days to Maturity	Borers per 100 Plants 8/1				Required Diff. 5% Level	Per Cent Control		
		5% DDT	40% *Ryania*	1% Rotenone	Untreated		5% DDT	40% *Ryania*	1% Rotenone
Early yellow	80	33.3	26.7	63.3	123.3	33.0	73.0	78.3	48.7
Golden Cross	84	26.7	13.3	33.3	153.3	54.8	82.6	91.3	78.3
Late yellow	88	53.3	23.3	63.3	146.7	63.2	63.7	84.1	56.9
Country Gentleman	92	70.0	43.3	143.3	266.7	68.8	73.8	83.8	46.4
Average		45.8	26.6	75.8	172.5		73.3	84.4	57.6
Pounds per acre		38.3	38.9	46.5					

Dusts made from ground stems of *Ryania speciosa* Vahl. have been found to be highly effective against the corn borer (Pepper & Carruth 1945). In our tests, *Ryania* was tested principally as a 40 per cent dust, but during the last season 20 and 30 per cent dusts were included also. In one 1947 test, a 40 per cent impregnated *Ryania* dust was compared with the regular mechanically mixed dust of *Ryania*. Only one *Ryania* formulation was tried in which a supplemental material was incorporated. This was a 40 per cent dust plus 4 per cent hemo-serum sticker.

In the 1948 test a 2 per cent parathion dust was included for the first time. This new insecticide was available in 1947 but the quantities at that time were not sufficient for large plot experiments.

The rates of dust application for each

hemoserum in test four was the lowest of all DDT treatments and significantly lower than DDT in Eastern magnesia talc without the sticker. In fact most of the DDT-talc dusts containing additive materials were more effective than straight DDT-talc dust. Likewise in this same test, the clay used as a diluent was superior to either pyrophyllite or Eastern magnesia talc as diluents. Why these relationships did not remain the same in the other four tests which had lower borer populations is hard to explain.

The addition of methylnaphthalene or lubricating oil to DDT-talc dust did not show any advantage except in test four where the 3 per cent S.A.E. 10, oil addition to the dust resulted in significantly better borer reduction. An interesting point was brought out in test 2 (second

generation 1946) where the non-volatile methylnaphthalene was used at a concentration of 10 per cent. The borer population following the use of this dust was unexpectedly high. It is thought that such a high content of oily material impaired the physical properties of the dust and poor distribution was the limiting factor in control. The application of DDT as a 10 per cent dust at 15 lbs. per acre gave somewhat poorer control than 5 per cent DDT at 30 lbs. per acre, but the difference was not significant.

Table 3.—Comparison of parathion and DDT for corn borer and earworm control, 1948.

Dust	Corn Borers 100 Plants	Earworms 100 Plants
2% parathion 2 appl.	156	472
2% parathion 1 appl.	216	584
5% DDT 2 appl.	660	276

The use of methoxychlor in tests 1 and 3 revealed the inferiority of this chemical for corn borer control. Chlorinated camphene and dichloro dephenyl-dichloroethane showed somewhat better control than methoxychlor but neither one did as well as DDT. However, the borer survival shown for chlorinated camphene in test 4 was not significantly higher than the survival resulting from the use of DDT-talc.

Mechanically mixed *Ryania*-talc dust at 40 per cent concentration was the outstanding insecticide used throughout these experiments. A comparable experimental dust made by impregnating *Ryania* on the diluent was significantly poorer than the mechanically mixed dust. The addition of 4 per cent hemo-serum sticker to *Ryania* dust did not show any advantage. Reducing the *Ryania* content to 30 and 20 per cent resulted in poorer control than the 40 per cent strength, but the differences were so close as to be insignificant.

The superiority of *Ryania* for corn borer control was demonstrated also in our 1947 test of three insecticides on early planted canning corn (Table 2). Four applications were made of the three insecticides commonly used for corn borer control during recent years; namely 40 per cent *Ryania*, 5 per cent DDT and 1 per cent rotenone. On each of the four sweet corn varieties, *Ryania* gave better control than DDT which in turn was superior to rotenone in all cases.

The first trial with parathion (1948) showed that 0.6 lb. of the insecticide per acre per application resulted in a lower borer population than obtained with 1.5 lbs. of DDT. However, due to the experimental error inherent in large plot testing against a low borer population, we were unable to show a significant advantage for parathion over DDT.

A large plot evaluation of parathion was conducted during 1948 against the second generation borer on sweet corn. Parathion at 2 per cent concentration was applied by plane at 33 lbs. per acre. One three acre plot had one application August 24 and another three acre plot received applications August 24 and 30. An adjoining plot was aerial dusted twice with five per cent DDT at 35 lbs. per acre. The results obtained by dissecting 25 plants at random from each plot on September 10 are shown in table 3. While parathion gave outstanding control of the corn borer in this test, its effectiveness against corn earthworms was very disappointing.

Foliage samples were collected at intervals following the applications of parathion. These samples were dried and sent to the U. S. Bureau of Entomology and Plant Quarantine for residue analysis. Silage made on September 25 from the parathion treated corn was analyzed November 5 for a final determination. The results of these analyses are given in Table 4.

Table 4.—Parathion residues in p.p.m. on sweet corn foliage following applications for corn borer control (2% Parathion—33 lbs./acre).

Date Foliage Collected	Treatment Dates: Aug. 24 Dry Wgt.	Aug. 24 Green Wgt.	Aug. 24 & 30 Dry Wgt.	Aug. 24 & 30 Green Wgt.
Aug. 26	6.85	1.12	6.85	1.12
Aug. 30	0.4	0.07	0.4 (Before Tr.)	0.07
Aug. 31	—	—	6.2	1.02
Sept. 7	0.4	0.07	1.25	0.20
Sept. 16	0.7	0.11	0.6	0.10
Nov. 5 (Silage sample)		0.02	—	—

These data show a parathion residue of 6 to 7 p.p.m. of dry weight or 1 p.p.m. of green weight on corn foliage a day or two following the application of 0.67 lbs. of

parathion per acre in dust form. One week later only 10 to 20 per cent of this residue remained.

The parathion found in silage was at a very low level. However, the 0.02 p.p.m. in silage is not directly comparable to the other single treatment determinations because the latter residues were found on leaves exclusively while the silage included leaves and stalks but not the ears and husks. The weight added to the silage by the stalks would tend to depress the relative amount of toxicant because this part of the plant would retain very small amounts of dust in comparison with the foliage.

SUMMARY.—Three years of experience with insecticidal dusts for corn borer control on canning corn showed 40 per cent *Ryania* to be the most effective treatment. Parathion at 2 per cent concentration showed exceptional promise during the final year. Five per cent DDT was found to be more effective than equal concentrations of dichlorodiphenyl dichlorothane chlorinated camphene, methoxychlor and 1 per cent rotenone.

Under conditions of light borer infestation, there seemed to be no advantage derived from the use of three different diluents nor from the addition of hemoserum sticker, soy flour, sulphur, oil or solvents to 5 per cent DDT dust. In fact, DDT dust impregnated with 10 per cent non-volatile solvent definitely impaired borer control.

One test conducted against a moderately high borer infestation did show an advantage for *Attapulgus* clay over pyrophyllite and *Eastern Magnesia Talc* as a diluent for 5 per cent DDT. In this same test, DDT dust containing 2 per cent hemo-serum gave the highest degree of borer control of several DDT formulations tested.

Sweet corn treated with 2 per cent parathion at the rate of 33 lbs. per acre showed a parathion residue on the foliage of 6.8 p.p.m. of dry weight two days following application. Twenty-one days later the residue was down to 0.7 p.p.m. of dry weight. Seventy-one days later silage made from the whole plants minus the ears showed only 0.02 p.p.m.

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Host-Plant Sources of *Lygus* Spp. Infesting the Alfalfa Seed Crop in Southern Arizona and Southeastern California

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Damage by plant bugs of the genus *Lygus* to the alfalfa-seed crop in the important seed-producing areas has become evident during recent years. Sorenson (1932) was the first to show that injury by *Lygus* bugs to alfalfa flowers results in a variable amount of flower fall, depending on the population and length of exposure. In later studies (1939) he confirmed his earlier observations and also showed that the blighting of alfalfa buds and shriveling of alfalfa seeds were caused by their feeding. Stitt (1940) reported significant positive correlations between *Lygus* populations and flower fall and also between *Lygus* numbers and brown or damaged alfalfa seed in southern Arizona and southeastern California. Histological and field studies by Carlson (1940) showed the physiological reactions of the alfalfa plant to *Lygus* infestations. Shull and Fisher (1941) reported that a definite relation between *Lygus* populations on alfalfa at the beginning of the blossoming period and seed production occurred in Idaho. Wilkinson (1941) stated that *Lygus* is one of the worst pests of alfalfa seed in Utah.

The purpose of the studies herein reported was to determine the importance of the different host plants as sources of *Lygus* populations in the main alfalfa-seed-producing areas of southern Arizona and southeastern California. *Lygus* migrations from other host plants to alfalfa-seed fields were observed every year from 1935 to 1942. When these migrations were of sufficient magnitude, damage to the alfalfa-seed crop was severe, and many crops were a failure. The studies showed what plants furnish habitats favorable for the development of high *Lygus* populations that migrate into and damage the main alfalfa-seed crop, which develops during the period from late in April to the early part of July and which is most attractive to the bugs during May and June. The information obtained was useful in the experimental community cultural program for the control of *Lygus* bugs in the alfalfa-seed fields of the Mohawk area in Arizona (Stitt 1941).

Three species of *Lygus*—namely, *L. hesperus* Knight, *L. oblineatus* (Say), and *L. elisus* Van Duzee—are of economic importance in the alfalfa-seed fields of southern Arizona and southeastern California. *L. elisus* has been of minor importance, however. Stitt (1940) showed that approximately 90 per cent of the *Lygus* collected in alfalfa-seed fields during the years 1935–37 were *L. hesperus*, about 8 per cent were *L. oblineatus*, and the remainder, or less than 2 per cent, were *L. elisus*. Recent changes in cropping practices have apparently caused a change in the percentage of *Lygus* species in some alfalfa areas. Where sugar beets were grown for seed, or where *Polygonum argyrocoleon* Steud. was abundant in flax fields, a recent increase of these crops gave rise to a corresponding increase of *L. oblineatus* in adjoining alfalfa-seed fields. In Yuma County, Arizona, during 1940 and 1941, over 50 per cent of the *Lygus* examined in some alfalfa-seed fields in May and early in June were *L. oblineatus*. However, late in June and early in July, when *L. hesperus* populations increased and reached their peak, the percentage of *L. oblineatus* decreased.

Methods and Materials.—*Lygus* population counts on individual species of plants were obtained by sweeping with a 15-inch insect net. The preferred number of sweeps per record was 100, but the actual number ranged from 10 to 500, depending on the size of the area covered by the host-plant unit. One sweep consisted of one movement of the net from right to left, or the reverse, either through the tender or the flowering parts of the plants. Stitt (1940) found *Lygus* popula-

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tions most abundant on alfalfa during the flowering stage of plant development; and found that both adults and nymphs prefer to frequent the buds, flowering parts, and tender terminal parts of the plants. Therefore, in the investigation here reported the plants were swept mainly during the budding and flowering stages. Care was exercised to sweep only pure stands of the different species, except where there was a general mixture of desert annuals, and records were kept accordingly.

The data from this investigation were obtained during the period 1936 through the first half of 1942. Most of the sweepings were taken in Yuma and Maricopa Counties of Arizona and in the Bard area in Imperial County of California. About 80 per cent of the alfalfa seed produced in Arizona in grown in Yuma and Maricopa Counties.

Data were recorded on location and date of sweeping, name and habitat of plant, number of sweeps, number of *Lygus* adults and nymphs taken per sweep, and total number of *Lygus* collected. The information has been summarized in table 1 by plant species or mixtures of species. The mixtures consisted of several species growing together or of pure stands of single species that were so limited that less than 10 records, or 1,000 sweeps, were obtained from them. The 40 species or groups do not represent all the plants on which the three species of *Lygus* were found in the study areas, but do include all the common and widely distributed plants that have a relation to *Lygus* populations in alfalfa-seed fields of southern Arizona and southeastern California.

The areas studied included two natural divisions, "desert" and "river valley." The desert consisted of upland terraces and mesas. The river valleys consisted of almost level, alluvial land of fairly recent formation and included both irrigated and unirrigated habitats. The main alfalfa-seed crop is grown on the irrigated river-valley lands. Data on *Lygus* populations on different plants are assembled in table 1 according to population densities, the principal habitat of each plant or plant group being indicated in column 1.

RESULTS.—From plants other than alfalfa a total of 1,195 records were obtained in which 26,817 *Lygus* were captured in 134,361 sweeps, or an average of 20 bugs per 100 sweeps. Of the records 792 were obtained in river-valley areas and 403 in desert areas. A total of 24,432 bugs were captured, or an average of 32.7 per 100 sweeps on plants in river-valley areas, as compared with a total of 2,385 captured, or an average of 4 per 100 sweeps in desert areas. Using either globemallow (*Sphaeralcea* spp.) or all plants swept in a habitat, the *Lygus* populations were approximately eight times greater on the plants in the river valley than on the plants in the desert. The records on globemallow in both habitats were as follows: 3975 sweeps in river-valley areas gave an average of 23.7 bugs per 100 sweeps, and 3200 sweeps in desert areas gave an average of 2.7 per 100 sweeps. Similar records obtained by making 41,300 sweeps on alfalfa grown for seed gave 27,128 adults and 64,788 nymphs, or an average of 222.6 *Lygus* per 100 sweeps. The nymphal populations on alfalfa (*Medicago sativa* L.), *Basia hyssopifolia* (Pall.) Ash., vetch (*Vicia* spp.), sugar beet (*Beta vulgaris* L.) Chinese-pussley (*Heliotropium curassavicum* var. *oculatum* (Heller) Johnston), horseweed, (*Erigeron canadensis* L.), and *Aster exilis* Ell. indicate the suitability of these plants as hosts of *Lygus*.

The species of plants are grouped in table 1 according to average populations of *Lygus* per 100 sweeps, with a summary for each species. Of the groups of plants on which the population was less than 1 *Lygus* per 100 sweeps, 7 were in the desert and 4 were in river-valley areas. Populations averaged 1–10 bugs per 100 sweeps on 12 species or mixtures, 6 of which were in desert and 6 in river-valley areas. Nine out of 12 species or mixtures from which 10–100 bugs were taken per 100 sweeps were in river valleys, 2 were in the desert, and 1 was present in both habitats. All the average *Lygus* populations of more than 100 bugs per 100 sweeps were obtained on species growing in river valleys Of the 40 species or mixtures of species listed in table 1, 15 were found predominantly in the desert, 24 in the river valleys, and 1 (globemallow) in both habitats. Fourteen of the 24 species or mixtures growing in the river valleys yielded 10 or more *Lygus* per 100 sweeps, whereas only 3 of the 16 species or mixtures growing in the desert yielded 10 or more *Lygus* per 100 sweeps, and none of these were

Table 1.—Average populations of *Lygus* spp. on different plants at time of budding and flowering as indicated by net sweepings during years 1936–1942.

	Name of Plant	Common Name[1]	Records	Sweeps	Adults	Nymphs	Total	Average per 100 Sweeps
			Less than 1 *Lygus* per 100 sweeps					
D[2]	*Atriplex* spp.	Saltbush	22	2,250	1	0	1	0.1
D	*Chaenactis* spp.	—	8	1,475	0	0	0	0
IRV	*Cynodon dactylon*	Bermuda Grass	16	1,600	0	0	0	0
D	*Franseria dumosa*	White bur-sage	25	2,750	3	7	10	.4
D	*Larrea tridentata*	Creosote bush	45	8,425	0	0	0	0
D	*Lesquerella gordoni*	—	12	1,600	1	3	4	.3
D	*Prosopis juliflora*	Common mesquite	20	1,975	0	0	0	0
IRV	*Salsola kali* var. *tenuifolia* Tausch	Russian thistle	15	1,525	1	9	10	.7
RV	*Suaeda torreyana*	—	16	1,550	8	0	8	.5
D	Desert annuals	—	79	7,965	83	69	152	.9
IRV	Small grains and flax	—	28	4,100	14	0	14	.3
			From 1 to 10 *Lygus* per 100 sweeps					
D	*Abronia* spp.	Sand verbena	15	2,500	21	5	26	1.0
D	*Baileya* spp.	Desert-marigold	19	1,825	98	73	171	9.4
D	*Encelia farinosa*	Brittlebush	18	1,350	11	9	20	1.5
D	*Franseria deltoidea*	—	40	6,580	29	4	33	5.0
IRV	*Helianthus annuus*	—	20	1,650	92	2	94	5.7
IRV	*Malva parviflora*	—	21	1,625	16	3	19	1.2
D	*Matricaria matricarioides*	Pineapple-weed	8	1,000	5	19	24	2.4
IRV	*Medicago hispida*	Bur-clover	19	1,650	98	16	114	6.9
IRV	*Melilotus indica*	Sourclover	21	2,000	123	28	151	7.5
IRV	*Rumex* spp.	Dock	18	2,250	146	17	163	7.2
IRV	*Sonchus* spp. and *Lactuca* spp.	Sow thistle and wild lettuce	17	1,775	17	0	17	1.0
D	Desert perennials	—	43	4,830	37	23	60	1.2
			From 10 to 100 *Lygus* per 100 sweeps					
RV	*Actinea odorata*	Fragrant-bitterweed	69	5,635	1,470	2,252	3,722	66.1
IRV	*Amaranthus* spp.	Pigweed	17	1,575	126	40	166	10.5
IRV	*Chenopodium murale*	Nettleleaf goosefoot	49	3,061	736	576	1,312	42.9
RV	*Dithyrea wislizeni*	—	12	1,225	176	289	465	38.0
RV	*Bassia hyssopifolia*	—	17	1,660	25	410	435	26.2
D	*Geraea canescens*	—	25	2,525	758	726	1,484	58.8
RV	*Oligomeris linifolia*	—	14	1,400	539	414	953	68.1
D	*Palafoxia linearis*	Spanish-needles	25	2,600	183	155	338	13.0
IRV	*Sisymbrium irio*	—	204	20,670	1,478	1,745	3,223	15.6
RV & D	*Sphaeralcea* spp.	Globemallow	65	7,175	695	334	1,029	14.3
IRV	*Vicia* spp.	Vetch	12	1,200	89	247	336	28.0
IRV	Weedy mixtures	—	49	5,075	722	631	1,353	26.7
			Over 100 *Lygus* per 100 sweeps					
IRV	*Beta vulgaris*	Sugar beet	18	1,705	607	2,306	2,913	170.9
IRV	*Erigeron canadensis* and *Aster exilis*	Horseweed	35	1,560	545	2,232	2,777	178.0
IRV	*Heliotropium curassavicum* var. *oculatum*	Chinese-pussley	22	1,510	720	1,791	2,511	166.3
IRV	*Polygonum argyrocoleon*	—	17	1,535	1,317	1,392	2,709	176.5
IRV	*Medicago sativa*	Alfalfa[3]	—	41,300	27,128	64,788	91,916	222.6

[1] Authority for common names: Kearney, T. H., and R. H. Peebles. Flowering plants and farms of Arizona. U. S. Dept. Agr. Misc. Pub. 423, 1,069 pp., 1942.

[2] Plants predominantly in the desert areas, RV, those in unirrigated river-valley areas, D, and IRV, those in irrigated river-valley areas.

[3] Seed alfalfa only. Does not include sweepings from alfalfa grown for hay.

among the 5 species or mixtures (including alfalfa) that yielded more than 100 *Lygus* per 100 sweeps. It is thus apparent that, as potential sources of *Lygus* infesting alfalfa, the host plants in the river-valley areas were much more important than those in the desert, both because of the higher populations they harbored and because of their proximity to it.

DISCUSSION.—Plant growth in the unirrigated areas of southern Arizona and southeastern California is limited by the amount and season of rainfall. Peak *Lygus* populations were present on plants in the flowering stage of development. *Lygus* dispersals from host plants to alfalfa-seed fields from late in April through June caused the most serious damage to the main alfalfa-seed crop. Desert vegetation, during years of average rainfall, was usually maturing and unsutitable for increases of *Lygus* populations before the latter part of April, and the average infestation on this type of plant growth was very low, only 4 bugs per 100 sweeps. These populations were not large enough for migrations that could be detected, and they probably were not a factor in causing serious damage to the alfalfa-seed crop. Heavier than normal rainfall during the winter and spring caused a more luxuriant and later maturing desert vegetation, which produced higher *Lygus* populations. Only one notable *Lygus* migration was observed from strictly desert plants into alfalfa fields during the development of the seed crop. This migration occurred in May 1941 in the Mohawk area of Yuma

County, Ariz. A comparative study of the data from this investigation and of rainfall records for 71 years indicates that only occasionally is development of desert plants and *Lygus* populations synchronized well enough with an attractive stage of alfalfa growth to cause damaging *Lygus* movements from desert plants to the main seed crop.

Data on sweepings indicated that the unusual movement of *Lygus* in 1941 was coming mainly from *Geraea canescens* Torr. and Gray, which was growing abundantly on the desert land surrounding the Mohawk alfalfa-seed-producing area. The plants were maturing, the second-generation *Lygus* were reaching the adult stage, and the populations were rapidly decreasing on the desert plants during the period of rapid increase of the bugs on alfalfa. *L. hesperus* comprised a majority of the *Lygus* adults in both habitats. *G. canescens* was observed in limited acreages during other years, but in 1941 it was present over many square miles. The plant remained green and continued flowering until May, later than in any other growing season observed by the writer. Desert vegetation in general was profuse from January through May 1941 and, like *G. canescens*, other large annuals also continued their growth over an extended period. Rainfall was adequate from December 1940 through April 1941 for continuous plant growth, retarded maturity, and the development of a type of plant growth of *G. canescens* that was favorable for producing two generations of *Lygus*. Rainfall records of the U. S. Weather Bureau Station at Yuma, Arizona, showed that 0.25 inch or more of rain fell during each month from December 1940 through April 1941, and that this period constituted the only one in 71 years during which monthly rainfall was adequate for continuous plant growth.

Most of the *Lygus* migrations into alfalfa-seed fields, during this investigation, were from sources within irrigated river-valley areas and were observed under one or more of the following conditions: Nonconformity of some ranchers to a uniform program of cutting alfalfa hay preceding the seed crop, cutting of mixed barley alfalfa hay, cutting of flax fields containing an abundance of *Lygus*-infested *Polygonum argyrocoleon* Steud., the maturity or harvesting of sugar beet seed crops, or following the maturity of *Sisymbrium irio* L.

The data gave no evidence that 24 of the 40 plant species and mixtures studied were sources of damaging *Lygus* migrations to the main alfalfa-seed crop. Reasons for this nonoccurrence of serious movements from these plants were absence or very low populations of *Lygus* or the presence on the plants of adults only, limited acreage of plants, or seasonal development of the host plant.

Plant species on which no *Lygus* were captured were: *Chaenactis* spp., Bermuda grass (*Cynodon dactylon* (L.) Pers.), creosotebush (*Larrea tridentata* (DC.) Coville), and common mesquite (*Prosopis juliflora* (Swartz) DC.). Only adults were captured by sweeping saltbush (*Atriplex* spp.), *Suaeda torreyana* S. Wats., small grains and flax, and sowthistle (*Sonchus* spp.), and wild lettuce (*Lactuca* spp.), and their presence was only incidental and not a source of increase in *Lygus* populations.

Plants on which low *Lygus* populations were found and which covered limited acreages were as follows: Sandverbena (*Abronia* spp.), desert-marigold (*Baileya* spp.), *Helianthus annuus* L., *Lesquerella gordoni* (A. Gray) S. Wats.; *Malva parviflora* L., pineapple-weed (*Matricaria matricarioides* (Less.) Porter), dock (*Rumex* spp.), Russian-thistle, (*Salsola kali* var. *tenuifolia* Tausch), sowthistle (*Sonchus* spp.), wild lettuce, (*Lactuca* spp.), and *Suaeda torreyana* S. Wats.

Plants with low *Lygus* populations in the desert habitat which matured or became unfavorable for the plant bugs and caused them to migrate before the attractive period of development of the main alfalfa-seed crop during years of average rainfall were as follows: Brittlebush (*Encelia farinosa* A. Gray), *Franseria deltoidea* Torr.; white bur-sage (*Franseria dumosa* Gray), *Lesquerella gordoni* (A. Gray) S. Wats. desert annuals, and desert perennials.

Plant species on which *Lygus* peak populations did not occur until after the main alfalfa seed crop was mature were pigweed (*Amaranthus* spp.), *Bassia hyssopifolia* (Pall.) Asch., horseweed (*Erigeron canadensis* L.,) and *Aster exilis* Ell., the last two being usually found growing as a mixture.

Lygus populations on 15 species or mixtures of plants occurred at a period of the

year or in sufficient numbers to permit dispersals to alfalfa-seed fields. Some of this group were potential sources of *Lygus* every year, and others were only occasionally a source of infestation.

The plant species which were a possible or occasional source of *Lygus* migrations to alfalfa seed fields were fragrant-bitterweed (*Actinea odorata* (DC.) Kuntze), *Geraea canescens* Torr. and Gray, *Oligomeris linifolia* (Vahl) Macbride, and Spanish-needles (*Palafoxia linearis* (Cav.) Lag.).

Fragrant-bitterweed was very abundant in Yuma County. Its average *Lygus* population was 66.1 bugs per 100 sweeps, which was sufficient for dispersal, but no migration of bugs from this plant into alfalfa was detected. Of 63 *Lygus* adults swept from this host and examined, 9 were *L. hesperus*, 25 *L. oblineatus*, and 29, or almost one-half of the specimens in the sample, were *L. elisus*, a species that has been of very minor importance in the alfalfa-seed fields of the area studied.

Lygus populations on *Geraea canescens* were rarely sufficient when the alfalfa-seed crop was being grown to have supplied bugs for migration to that crop in injurious numbers. One unusual migration from *G. canescens* to alfalfa has been discussed earlier in this paper.

Oligomeris linifolia was at its optimum growth in 1940. *Lygus* populations that year averaged 158.7 per 100 sweeps, as compared with 0.5 bug per 100 sweeps the following year. The areas covered by thick stands of this plant were small, however, and during the year of optimum growth the peak bug population occurred in March, several weeks before the start of the alfalfa-seed crop. After that time the number rapidly decreased. Data obtained do not indicate that this plant was an important source of *Lygus* infesting alfalfa-seed fields.

Spanish-needles grow mainly in scattered stands in sandy areas. An average *Lygus* population of 32 bugs per 100 sweeps was recorded for 1940, when the plant growth was optimum. In 1941, under normal conditions, the average was only 3 bugs. Indications were that only rarely would this plant be a possible source of increased *Lygus* populations in the alfalfa-seed fields.

The plant species or mixtures that were yearly potential sources of *Lygus* populations infesting the main alfalfa-seed crop were as follows: Sugar beets (*Beta vulgaris*), nettleleaf goosefoot (*Chenopodium murale* L.), *Dithyrea wislizeni* Englem.; Chinese-pussley (*Heliotropium curassavicum* var. *oculatum*), bur-clover (*Medicago hispida* Gaertn.); sourclover (*Melilotus indica* L.), *Polygonum argyrocoleon* Steud., *Sisymbrium irio* L., globemallow (*Sphaeralcea* spp.), vetch (*Vicia* spp.), and weedy mixtures.

Dithyrea wislizeni and vetch were limited in distribution. The former was found mainly along the river beds in Maricopa County, and the data did not show any *Lygus* movements from it. Vetch has been grown mainly at the experimental stations as a cover crop. Unless this plant becomes widely used by farmers, it will not be a source of *Lygus* increases in alfalfa fields. Bur-clover was common in Maricopa County, but extremely scarce in Yuma County. The population on this plant was low, averaging 6.9 bugs per 100 sweeps, which indicates that bur-clover was not a source of any large *Lygus* dispersals. If bur-clover were heavily pastured at regular intervals of 30 days, few *Lygus* would develop on it. Sourclover has been used as a cover crop in the alfalfa-seed-producing areas and should be turned under before the seed crop is started. *Lygus* numbers on this plant were low, averaging 7.5 bugs per 100 sweeps, but where sourclover adjoins an alfalfa-seed field there is probably a movement into the alfalfa. Chinese-pussley grows chiefly in Yuma County, and extremely high *Lygus* populations were found on this plant, the average being 166.3 bugs per 100 sweeps. More than 97 per cent of these were found to be *L. elisus*, which was of minor importance in the seed fields. This plant should be destroyed around alfalfa-seed fields because *Lygus* move to it from alfalfa and subsist on it during the harvesting of alfalfa for hay, and then migrate back to alfalfa as soon as the seed crop starts to grow. Globemallow is not usually abundant in many alfalfa-seed-growing areas and apparently was of minor importance as a source of *Lygus*, since the small proportion of nymphs to adults found on plants of this genus indicated that the latter were comparatively poor hosts.

Sugar beets have been grown for seed since 1935 in Maricopa County. The crop

matures and is harvested late in May and during June, thus forcing a *Lygus* migration at a time when the alfalfa-seed crop is in an ideal stage of development for bug damage. *Lygus* populations averaged 170.9 bugs per 100 sweeps on sugar beet, which is 1 of the 5 plant species with the highest populations. Of 397 *Lygus* adults examined from this host, there were 74 *L. hesperus*, 321 *L. oblineatus*, and 2 *L. elisus*. Where sugar beets are grown for seed they are a prolific source of *Lygus* infesting alfalfa-seed fields in the same areas.

The winter annual, nettleleaf goosefoot, produced a growth favorable for the earliest nymphal development late in the winter and also subsistence of the *Lygus* bugs when the hay crops were cut. Although the population averaged 42.9 bugs per 100 sweeps, the acreage covered by the plant was limited and apparently dispersals from it were small; nevertheless it should be destroyed in and around all alfalfa fields. Of 90 adult specimens of *Lygus* swept from nettleleaf goosefoot and examined, 63 were *L. hesberus*, 25 *L. oblineatus*, and 2 *L. elisus*.

Polygonum argyrocoleon grows luxuriantly mainly in Yuma County. Optimum conditions for growth of this plant occur in flax fields sown in drill rows 6 inches apart. *P. argyrocoleon* is undisturbed in its growth until the flax is harvested in May and early in June. *Lygus* bugs were not found on pure stands of flax, but in flax fields containing *P. argyrocoleon* populations were very high, and the ideal conditions for growth of the weed were also favorable for continuous development of the bugs. The acreage of flax has incresed rapidly in Yuma County since 1937. This change in the acreage, with an attendant increase in the abundance of *P. argyrocoleon*, has apparently increased the *L. oblineatus* population in alfalfa-seed fields because approximately 50 per cent of the *Lygus* adults in these fields were *L. oblineatus* in localities where flax containing *P. argyrocoleon* was abundant. However, much lower percentages of this species occurred in other alfalfa-seed-growing localities. The average *Lygus* population on *P. argyrocoleon* was 176.5 bugs per 100 sweeps, one of the highest recorded during this investigation. Of the *Lygus* adults examined, 27 were *L. hesperus*, 201 were *L. oblineatus*, and 9 were *L. elisus*.

Polygonum argyrocoleon in flax fields should be controlled by cultivation, because it competes with the flax for plant food, heavily contaminates the flaxseed crop with its seeds, and, most important, furnishes an ideal habitat for the breeding of *Lygus* bugs that migrate at flax harvest time to alfalfa-seed fields. Fortunately, cultural practices in Yuma County were changing by 1942. The flax was being planted with a wider space between the rows, so that it could be cultivated to destroy *P. argyrocoleon* and other weeds.

Sisymbrium irio, a yellow-flowered mustard, grows abundantly in all alfalfa-seed-growing areas of Arizona and in the Bard section of California. It is present in the irrigated areas from November until May, by which time it is mature. *Lygus* populations on it were low, averaging only 15.6 bugs per 100 sweeps, but owing to the abundance of the plant in waste places and in fields of alfalfa and other crops in all areas, the aggregate *Lygus* population produced on it was very large. A count of *Lygus* specimens swept from *S. irio* and examined showed 101 *L. hesperus*, 206 *L. oblineatus*, and 5 *L. elisus*. Each year noticeable *Lygus* increases in seed alfalfa occurred when *S. irio* matured, but the amount of the increase due to this cause could not be determined, since there was a coincidental movement from the alfalfa-barley hay crop at harvest time. All alfalfa-seed growers and farmers should therefore destroy *S. irio* whenever possible.

Weedy mixtures were common in some cultivated areas. In many cases, these mixtures included some of the plants already discussed. Because of the close proximity of two or more species of plants, it was impracticable to determine the numbers of *Lygus* on the individual species. The average *Lygus* population on weedy mixtures, although not high, being 26.7 bugs per 100 sweeps, was sufficient to be a potential source of *Lygus* bugs, which infested the alfalfa-seed crop. This was particularly true when the weedy mixtures grew near alfalfa fields. Elimination of weeds by clean cultural practices would probably help reduce *Lygus* populations in alfalfa fields.

SUMMARY.—Reduction of seed yields

as a result of *Lygus* damage is an important problem in alfalfa-seed-producing areas of southern Arizona and southeastern California. The species involved are L. *hesperus* Knight, L. *oblineatus* (Say), and L. *elisus* Van Duzee, in descending order of importance. Data on *Lygus* populations on different plants that might be sources of infestations attacking the main alfalfa-seed crop were obtained during the years from 1936 to the middle of 1942.

A total of 1195 records were made on 39 separate plant species or mixtures of species (exclusive of alfalfa), in which 26,817 *Lygus* were captured in 134,361 sweeps with a 15-inch hand net, or an average of 20 bugs per 100 sweeps. *Lygus* populations averaged 4 bugs per 100 sweeps on plants growing in the desert habitat and 32.7 bugs per 100 sweeps on plants in the river valleys where cultivated crops, including the alfalfa seed crop, were grown under irrigation on a part of the acreage. Data obtained indicated that during years of average rainfall the desert plants matured or became unfavorable for *Lygus* populations before the main alfalfa-seed crop was started, and *Lygus* dispersals from them also took place before that time.

Owing to low *Lygus* populations or to the time of year when they supported infestations, 24 of the 39 plant species or mixtures (exclusive of alfalfa) were not sources of *Lygus* infesting the main alfalfa-seed crop. Data and observations on *Lygus* populations on the different host plants indicate that practically all *Lygus* infestations in the main alfalfa-seed crop come from cultivated (irrigated) land in river-valley areas. Of the host plants other than alfalfa, only sugar beet (*Beta vulgaris* L.), *Polygonum argyrocoleon* Steud., and *Sisymbrium iroi* L. appeared to be sources of *Lygus* populations of such magnitude that, if migrations occurred, they would be synchronized with the development of the main alfalfa-seed crop. The control of weeds that are important has plants of *Lygus* spp. infesting seed alfalfa would apparently reduce *Lygus* populations that affect that crop.

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MITE RESEARCH GROUP

On February 4, 1949, members of the Division of Entomology and Parasitology of the University of California, following a staff meeting, organized a group in the Division to study the systematics and economics of plant and animal infesting mites. All the members are engaged in or interested in these animals and it is hoped that others who are interested in the same problems may be contacted from time to time with the various problems that arise in projected programs.

The following members make up the group: E. O. Essig, A. E. Michelbacher, W. W. Middlekauff, E. M. Stafford, L. M. Summers, A. D. Borden, N. W. Frazier, A. Earl Pritchard, Gordon L. Smith, W. Harry Lange, Jr., D. P. Furman, and L. M. Smith, chairman of this Mite Research Group.

The Effect of Some Insecticides on Black Fly Larvae in Alaskan Streams[1]

C. M. GJULLIN,[2] O. B. COPE,[3] B. F. QUISENBERRY,[2] and F. R. DUCHANOIS[2]

Black flies, or "whitesox" as they are called locally, are distributed throughout Alaska but are more prevalent in some areas than in others. Large numbers of larvae are found on trailing vegetation in sluggish, slow-moving streams, but the greatest numbers are present on rocks and sticks in the more rapid and turbulent streams. The adults emerge in the summer and fall. Their habit of hovering around the head and flying into the eyes, ears, and nose of their victim, as well as the painful swelling resulting from their bites, causes them to be a serious pest.

Fairchild & Barreda (1945) found that in swiftly flowing streams in Guatemala as little as 1 part of DDT to 10 million parts of water was completely effective against the larvae of these insects for a distance of 1000 meters. Garnham & McMahon (1947) eliminated *Simulium neavei* Roubaud, the vector of onchocerciasis, from the Kodera area in Kenya, South Africa, with strengths of 1 to 27 parts of DDT per million parts of water, but these applications also destroyed the fish in the streams. Prevost (1946) succeeded in destroying black fly larvae with DDT without killing fish, but gives no information on the dosages used.

The data reported in this paper are based on tests conducted in troughs and streams to investigate methods of black fly control and the effect of larvicides on fish and the insects they feed on. Fish, caddis fly larvae, and black fly larvae were tested simultaneously, but results on fish and caddis flies will be presented elsewhere. This work is a portion of a 2-year project. The number of treatments required, the best time of application in relation to the most effective control, and the least injury to resident and migrating fish are also to be investigated.

TROUGH TESTS.—Thirty-seven preliminary tests were made with the black fly larvae *Simulium venustum* Say and *S. vittatum* Zett., in a series of troughs set up on the banks of Otter Creek. Otter Creek originates at the stream outlet of Otter Lake, which is about 5 miles northeast of Anchorage. It is about 8 feet wide by 6 inches deep, with a flow of 3.2 to 4.5 cubic feet per second. The pH of the water ranged from 7.3 to 8.4, the temperature from 55° to 76° F., and the dissolved oxygen from 6.9 to 10.9 p.p.m. *S. venustum* and *S. vittatum* in all instars were present on the rocky bottom of the creek. The troughs were made of galvanized metal and were 6 feet long, 14 inches wide, and 12 inches deep. A screen-topped baffle board placed in the troughs near the outlet provided a pool when the water was pumped in and allowed the excess to drain into a pit. Water delivered by a centrifugal pump driven by a gasoline engine flowed into a supply trough, which delivered 22 liters per minute to each test trough. A few of the tests with high dosages of the toxicants in acetone solution were conducted in troughs in which no water was circulated. The insecticides were applied on a parts-per-million basis from 1-gallon aspirator bottles calibrated with a glass-stopcock attachment to deliver the required number of cubic centimeters per minute. They were added to the inflowing water, and mixed by use of baffle boards.

In each test 50 third- and fourth-instar black fly larvae in 40-mesh screen containers, 10 caddis fly larvae in 16-mesh screen containers, and 10 rainbow trout, which were not caged, were placed in the troughs. The trout ranged from 3 to 6 inches in length. The caddis fly larvae were of the genera *Hydropsyche* and *Halesus* and were one-half to full grown. A control trough with untreated water was used in each test. The insects and fish were exposed to the insecticides for 15 minutes and were then placed in screen cages in the stream. Observations on the effect of the toxicants were made during the treatment and after 24 hours. Emulsions and acetone solutions of DDT, gamma benzene hexachloride, chlorinated camphene, and chlordan were tested. All emulsions were made with 25 per cent of toxic chemical, 10 per cent of an aralkyl

[1] This work was conducted under a transfer of funds, from the Office of the Surgeon General, Department of the Army, and, in part, from the Bureau of Medicine and Surgery, Department of the Navy, to the Bureau of Entomology and Plant Quarantine.

[2] U. S. Dept. Agr., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine.

[3] U. S. Dept. Interior, Fish and Wildlife Service.

polyether alcohol[1] and 65 per cent of xylene. All acetone solutions contained 10 grams of toxicant per liter.

Trough tests indicated that dosages equal to or greater than those tolerated by the fish or the caddis fly larvae were required to obtain practical control of black fly larvae. At 20 p.p.m. DDT and chlordan in acetone solutions killed 82 and 91 per cent, of black fly larvae. These treatments did not kill the fish, but the respective mortalities of one species of caddis fly larvae were 100 and 90 per cent. The 20 p.p.m. of gamma benzene hexachloride in acetone solution killed 45 per cent of the black fly larvae, 80 percent of the rainbow trout, and 80 to 90 per cent of the caddis fly larvae. Emulsions and acetone solutions of DDT, chlordan, and chlorinated camphene applied at rates of 8 to 12 p.p.m. usually killed less than 30 per cent of the black fly larvae, up to 80 per cent of the rainbow trout, and up to 100 per cent of the caddis fly larvae. Emulsions of gamma benzene hexachloride at 1 p.p.m. killed 58 per cent of black fly larvae, 20 per cent of rainbow trout, and 90 per cent of one species of caddis fly larvae. The critical concentrations of emulsions and acetone solutions of these four insecticides to fish and fish food, as given in table 2, are based mostly on these trough tests. The stream tests provided data that were more useful for control purposes; therefore, the trough tests were discontinued.

STREAM TESTS.—Tests of insecticides in Otter Creek and in the north and south forks of Little Campbell Creek were begun in July and completed in August The north fork of Little Campbell Creek has its origin in the Chugach Mountain range about 25 miles southeast of Anchorage. It is about 4 feet wide by 5 inches deep, and is well shaded by the forest through which it flows. The volume of flow ranged from 0.92 to 1.52 cubic feet per second. the velocity from 2 to 3 feet per second, the pH from 7.5 to 7.6, the dissolved oxygen from 11 to 12 p.p.m., and the temperature from 42° to 43° F. This stream had a large population of fourth-instar *Eusimulium latipes* Fries on rocks and sticks.

The south fork of Little Campbell Creek, which also originates in the Chugach Range, is about 4 feet wide by 5 inches deep, and is also well shaded by a forest. The volume of flow ranged from 0.59 to 1.56 cubic feet per second, the velocity from 3 to 4 feet per second, the pH from 7.5 to 7.6, the temperature from 42° to 50° F., and the dissolved oxygen from 10.5 to 11 p.p.m. A large population of fourth-instar *Eusimulium latipes* was present on the rocks in this stream.

One hundred and eight tests against black fly larvae were made in sections of these streams. Ordinarily new sections were used for each test, but if a section was used a second time it was necessary to repopulate it with black fly larvae on rocks. Large numbers of these rocks were available upstream. Many of the larvae became detached while they were being transferred, but those that did not remained as long or longer than native larvae, when the two types were compared in larvicide tests. Rainbow trout and caddis fly larvae were exposed in screen cages in these stream sections during the tests.

Acetone solutions and xylene emulsions of DDT, gamma benzene hexachloride, chlordan and chlorinated camphene were prepared in the same way as in the trough tests. Tests were also made with fuel-oil and kerosene solutions containing 5 per cent of DDT, and with certain mono- and dimethyl-naphthalenes,[2] solutions containing 15 per cent of chlordan or chlorinated camphene.

A rectangular-type weir, as described by Parshall (1941), was installed on each of the three streams, and the rate of flow was measured each day before tests were begun. All insecticides were applied to the streams in a parts-per-million ratio on the basis of these measurements.

Emulsions, suspensions, and oil solutions made with DDT, chlordan, chlorinated camphene, gamma benzene hexachloride, and pyrethrum were tested. Tests were also made with fuel oil, a mixture of dimethyl phthalate, *n*-butyl mesityl oxide oxalate,[3] and 2-ethyl-1,3-hexanediol.[4] All these materials were applied to the middle of the stream with the same type of aspirator bottle used in the trough tests. For the suspensions made with wettable DDT, which required constant stirring while it was being dispensed,

[1] *Triton X-100.*

[2] *Velsical AR-50.*
[3] *Indalone*
[4] *Rutgers 612.*

Table 1.—Toxicity of several insecticides to black fly larvae in stream tests.

Toxicant and Formulation	Dosage in p.p.m.	Number of Tests	Tests in Which all Larvae Detached	Mortality Larvae in Cages After 24 Hours
DDT:				
Emulsion	0.03	1	0%	22%
	.05	2	0	26
	.1	2	0	45
	.2	2	50	38
	.3	1	0	30
	.5	4	75	69
	.7	5	100	78
	1	1	100	59
	5	1	100	78
Acetone solution	.1	3	66%	91%
	.2	2	50	88
	.3	5	100	84
	.5	2	50	—
Wettable powder (90%)	.7	2	50%	97%
	1	2	100	87
	1.5	1	100	—
Fuel-oil solution	.05	1	0%	22%
	.1	1	0	32
	.2	2	50	61
	.4	5	100	83
Kerosene solution	.3	1	100%	13%
Chlordan:				
Emulsion	.2	1	0%	16%
	.5	1	0	64
	1	1	0	34
	2	3	66	34
	4	1	100	83
Acetone solution	0.1	1	0%	37%
	.3	3	33	71
	.5	2	50	26
Fuel oil solution	.5	2	100%	49%
	1	1	100	81
Mono- and dimethyl naphthalenes solution	.5	3	66%	66%
	1	4	75	73
	1.5	1	0	47
Chlorinated camphene:				
Emulsion	.2	1	0%	46%
	.5	1	0	62
	1	1	0	98
	2	2	66	56
	4	2	100	80
	5	1	100	—
Acetone solution	.5	1	0%	40%
Fuel-oil solution	.3	1	0%	—
	.5	2	50	50%
Mono- and dimethyl Naphthalenes	.5	2	50%	82%
	1	1	100	87
	1.5	1	0	47

Table 1. (*Continued*)

TOXICANT AND FORMULATION	DOSAGE IN P.P.M.	NUMBER OF TESTS	TESTS IN WHICH ALL LARVAE DETACHED	MORTALITY LARVAE IN CAGES AFTER 24 HOURS
Gamma benzene hexachloride:				
Emulsion	.1	2	50%	17%
	.5	1	0	—
	.7	1	0	4
	1	1	100	25
Acetone solution	.1	1	0%	26%
	.3	1	0	26
	.5	2	50	50
Pyrethrum:				
Acetone solution	0.1	1	0	40%
Kerosene solution	.1	1	0	13
2-ethyl-1, hexanediole	.5	1	0	79
	1	1	0	17
Dimethyl phthalate	.7	1	0	9
	1	1	0	20
Dimethyl phthalate emulsion	1	1	0	24
n-butyl mesetyl oxide oxulate	2	1	0	15
Mono- and dimethyl naphthalanes	10	1	0	95
Fuel oil	7	1	0	—
	9	1	0	—
	10	1	0	—
Kerosene	20	1	0	—

an open vessel with a small hole in the bottom was used. All larvicides were applied to the streams to give a constant parts-per-million rate over a 15-minute period.[1]

Control of black fly larvae was considered effective when all the larvae in the test section had become detached at the end of 24 hours. The larvicides were applied to determine the minimum dosage required to control the three species found in these streams. In addition to observations on the detachment of larvae, 24-hour mortality data were obtained by placing larvae from the treated section of the stream in screened cages immediately after the 15-minute treatment period. The cages were placed in the stream, and the mortality was recorded after 24 hours. In several tests large dosages were applied to obtain information on the maximum amounts of larvicides that could be used without destroying fish and caddis fly larvae.

DDT was the most effective insecticide tested (Table 1). The acetone solutions were effective at 0.3 p.p.m. in four tests for 150 yards downstream and in one test for 880 yards. The fuel-oil solution was effective at 0.4 p.p.m. and the kerosene solution at 0.3 p.p.m. The minimum dosage of DDT in fuel oil was not established, The DDT emulsion was effective at 0.7 p.p.m. in four 150-yard and in one 880-yard test.

Chlordan was ineffective as an emulsion at 2 p.p.m., as an acetone solution at 0.5 p.p.m., and in solution[2] at 1.5 p.p.m., but was effective in a limited number of tests at 0.5 p.p.m. in fuel oil. Emulsions and solutions of gamma benzene hexachloride were ineffective at 0.7 and 0.5 p.p.m., respectively. Chlorinated camphene emulsion was effective at 4 p.p.m. and ineffec-

[1] Tests made on black fly larvae in 1948 have indicated that shorter periods of application may be equally effective. The minimum time required to cause complete detachment of *Prosimulium hirtipes* Fries with 0.3 p.p.m. of DDT in acetone was found to be 6 minutes.

[2] In *Velsicol AR-50*.

Table 2.—Summary of minimum effective dosages of insecticides for black fly larvae and maximum nonlethal dosages for rainbow trout and caddis fly larvae.

Toxicant and Formulation	Minimum p.p.m. for Black Flies	Maximum p.p.m. for Rainbow Trout	Maximum p.p.m. for Caddis Fly Larvae
DDT:			
Emulsion	0.7	3	5
Acetone solution	.3	30	10
Wettable powder	1	10[2]	10[2]
Fuel-oil solution	.4	10[2]	10[2]
Kerosene solution	.3	.3[2]	.3[2]
Gamma benzene hexachloride:			
Emulsion	1	1	0.1
Acetone solution	.5[1]	10	10
Chlorinated camphene:			
Emulsion	4	3	5
Acetone solution	.5[1]	5	.5
Fuel-oil solution	.5[1]	.5[2]	.5[2]
Commercial product[3] solution	1.5[1]	1.5[2]	1.5[2]
Chlordan:			
Emulsion	4	3	5
Acetone solution	.5[1]	20	10
Fuel-oil solution	.5	6	.5[2]
Commercial solvent	1.5[1]	10	1[2]
Pyrethrum:			
Acetone mixture	.1[1]	.1[2]	—
Kerosene solution	.1[1]	.1[2]	.1

[1] Ineffective at this dosage, which was the highest tested.
[2] Highest dosage tested.
[3] *Velsicol.*

tive at 2 p.p.m. The acetone solution of this material was ineffective at 0.5 p.p.m., and the fuel-oil and chlorinated camphene solutions were ineffective at 0.5 and 1.5 p.p.m., respectively.

Fuel oil alone and chlorinated camphene alone caused considerable larval detachment when large amounts were used, but were not completely effective. (The other materials named were ineffective.) An acetone-pyrethrum mixture and a kerosene solution of pyrethrum were ineffective at 0.1 p.p.m.

The larval mortality in the cages after 24 hours ranged from 4 to 97 per cent. In some tests detachment of the larvae in a stream section was 100 per cent when mortalities in the cages were as low as 25 per cent, but the average mortality in cages for all tests in which all the larvae had detached was 73 per cent.

Chlorinated camphene emulsions caused 60 per cent mortality of fish in one test at 4 p.p.m. No deaths among the trout or caddis fly larvae were attributable to the insecticides in tests made with, or near the minimum dosages required to give 100 per cent control of black fly larvae.

Minimum Effective Dosages and Maximum Nonlethal Dosages.—The minimum dosages of insecticides that were effective against *Simulium vittatum*, *S. venustum*, and *Eusimulium latipes*, and the maximum dosages that were tried and found to be nonlethal in trough and stream tests against rainbow trout and caddis fly larvae, are shown in table 2.

Discussion.—Of all the materials tested, DDT in acetone was best for black fly control, because it was effective against the larvae at 0.3 p.p.m. and nonlethal to rainbow trout at 30 p.p.m. DDT in fuel oil or in kerosene was about as effective as the acetone solution, and will probably be found to be the most practical formulation. Chlordan solution, which is relatively nontoxic to rainbow trout, may be found to be effective against black flies in low enough dosage to be considered. The other materials, with the possible exception of the chlordan-fuel oil solution and the gamma benzene hexachloride solution, were much more toxic to trout and should not be used. Toxicity of some of these materials to fish may have been due to the solvents and emulsifiers used in preparing them.

The variation in total alkalinity in terms of calcium carbonate and the pH observed in the three streams had no noticeable effect on the toxicity of the insecticides tested, but a larger series of standardized tests would be necessary to determine this fact definitely. High temperatures with consequent reduction of dissolved oxygen caused large differences in the toxicity of the chemicals to rainbow trout in a few tests in which comparisons could be made. Temperatures from 42° to 69° F. had no noticeable effect on the toxicity of the insecticides to black fly larvae. Wettable DDT was seen to settle on the bottom of the streams when used at strengths of 1 p.p.m. The flow was fairly rapid, and no settling out of other chemicals was observed; however, settling might occur with some chemicals in more sluggish streams.

The mortality of black fly larvae was considerably lower in the trough tests than in the stream tests. If the larvicides act as stomach poisons, the lower kill may be due to the cessation of feeding by the larvae that are disturbed before they are treated. The mortality of larvae confined in cages during stream tests shows that control resulted from detachment of the larvae and not necessarily from direct kill.

A large difference between the toxicity of an insecticide to black fly larvae and its toxicity to fish and fish food, such as is

afforded by a DDT-acetone suspension, is essential, since errors in calculating the rate of flow, as well as careless application of too large dosages, may result in the destruction of the fish and fish food in a stream. Streams may be measured most accurately by installing weirs, but this is usually impractical. Measurement of the speed of flow with a flowmeter or a floating stick, and then using this information in a formula, together with measurements of the stream depth as described by Davis (1938), will be sufficiently accurate for this purpose if carefully done.

The larvicides should be added to a turbulent spot in the stream to insure mixing. The use of a board under the outlet as a deflector or the use of multiple outlets will also help to secure better distribution.

Black fly larvae comprise only an insignificant portion of the good of fish in the region where the tests were made. This was shown in the examination of the stomach contents of several species of fish from heavily infested black fly streams in the area.

SUMMARY.—DDT, chlordan, chlorinated camphene, and gamma benzene hexachloride were tested as emulsions and acetone suspensions in troughs and stream sections in Alaska against larvae of the black flies *Simulium venustum* Say, *S. vittatum* Zett., and *Eusimulium latipes* Fries. These chemicals were also tested against caddis fly larvae of the genera *Hydropsyche* and *Halesus* and against rainbow trout. Tests of these chemicals in oil solutions and of pyrethrum were also made in the stream sections.

The DDT-acetone suspension caused all black fly larvae to become detached at 0.3 p.p.m. and was nonlethal to rainbow trout at 30 p.p.m. and to caddis fly larvae at 10 p.p.m. DDT in fuel oil was completely effective against black fly larvae at 0.4 p.p.m., and DDT in kerosene was effective at 0.3 p.p.m. These solutions were nonlethal to rainbow trout at 10 p.p.m. The chlordan-acetone suspension was nonlethal to rainbow trout at 20 p.p.m. and to caddis fly larvae at 10 p.p.m. Its minimum effective dosage for blackfly larvae was not determined, but 0.5 p.p.m. was not effective. A DDT-xylene[1] emulsion was effective against black fly larvae at 0.7 p.p.m., but was toxic to the fish at 5 p.p.m.

Chlorinated camphene and gamma benzene hexachloride were less effective aginst black fly larvae and were toxic to the fish at 1 to 10 p.p.m. Dimethyl phthalate, n-butyl mesityl oxide oxalate, 2-ethyl-1, 3-hexanediol, and fuel oil, kerosene, and mono- and dimethylnaphthene mixture were also ineffective against black fly larvae.

[1] With *Triton X-100.*

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Phyllobius intrusus Kono, a new weevil first reported in 1948 by Kerr, in Rhode Island, has been found in the counties of Fairfield and New London, in Connecticut and in Barnstable, Bristol, Middlesex and Worcester Counties in Massachusetts by Federal gypsy moth and Japanese beetle inspectors. This species has caused injury to roots of arborvitae and related conifers.

Control of Alaskan Mosquito Adults by Aerial Sprays[1]

F. S. Blanton,[2] C. N. Husman,[3] B. V. Travis,[3] and C. S. Wilson,[4,5]

Tests on the control of mosquito adults during the 1948 season in Alaska were conducted to determine the size of area necessary to treat in order to prevent infiltration in annoying numbers from the surrounding unsprayed areas, to obtain information on the number of times an area must be treated to protect a community from mosquitoes, and to establish the minimum effective dosage of DDT.

The Alaskan Command and the Alaska Insect project pooled supplies of DDT, planes, and personnel, and some of the military installations were used for the large-scale spray tests. Consequently, the Insect Project was able, in most cases, to combine research work with actual practical control activities for the local military installations. Large areas were sprayed at Ladd Field, near Fairbanks, Eielsen Field, 25 miles, and Big Delta, about 100 miles away.

Materials and Methods.—The plots were treated with a C-47 airplane equipped with a special spray apparatus designed by C. N. Husman and built by the Alaska Command. Standard 20 per cent DDT airplane spray containing either 40 per cent chlorinated camphene and 40 per cent fuel oil; 28 per cent chlorinated camphene and 52 per cent fuel oil; or 15 per cent chlorinated camphene and 65 per cent fuel oil was used undiluted in all except the reduced dosage tests. Fuel oil was used as a diluent to obtain reduced dosages of 0.05 (10 per cent DDT solution), and 0.025 (5 per cent DDT solution) pound of DDT per acre. One-half pint of liquid per acre was applied except in two tests where 2 pints of 20 per cent spray were used to give a dosage of 0.4 pound.

The sprays were applied at swath intervals of 800 feet in one direction and crosswind. The flight lines were marked with flags, or with smoke grenades, and in one instance with balloons, placed either at one end or in the middle of the plots. The pilots flew the swaths both by compass after orienting over the markers and by the use of maps on which the flight lines previously had been drawn. All sprays were applied between 1900 and 0300, as mosquito activity usually was greatest during this period. The wind was usually 0 to 8 miles per hour, although on a few occasions winds of 11 to 15 miles per hour were encountered. Inversion conditions were ideal for the application of small-droplet sprays.

Mosquito populations were determined before and at intervals after spraying by landing-rate counts at a number of selected locations in the test plots. Counts were made of mosquitoes landing on the front of the trousers, waist to cuff, after standing quietly for 3 minutes at the check station. All counts were made as near the same time of day as possible. Frequently, different observers made the counts, and in a few cases the counts were made by two observers at the same station.

Results. *Ladd Field Tests.*—The northern section of the area, Birch Hill, is a 6-square-mile block, bounded on the north by a line of hills about 200 feet high and on the south by the Chena River. Immediately adjacent on the south is the airfield. The southern section, Tanana, is a 24-square-mile block bounded on the north by the Chena River and on the south by the Tanana River. The general terrain is flat and marshy. Some portions are densely wooded with birch and alder, some have a moderately dense growth of spruce and larch, and some have only a low growth of shrubs, mostly *Betula nana*, and a considerable part of the area is a moss-sedge bog.

The Birch Hill area was difficult to spray since the hills were dotted with beacons, towers, and power lines. Wind conditions were more unstable in this area than in the Tanana sections. The pilot was required to fly one corner of the area with the plane higher than normal and with a tail-wind. Much of the spray drifted away from this area, resulting in a reduced dosage. This condition was particularly pronounced in the second spray at Ladd Field.

[1] This work was conducted under funds allotted by the Department of National Defense to the Bureau of Entomology and Plant Quarantine.

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[5] The writers are greatly indebted to other members of the Alaska Insect Project and especially to Nelson Smith who contributed to this work.

The total area sprayed included the air field and was approximately 6 by 5 miles. Two test applications were made for the control of adult mosquitoes, one the night of June 14 and the other the night of June 25. This area also had received a larvicidal treatment May 13, and subsequent to June 25 it received a routine spray by the Area plane.

The data, table 1, show that an average of 98 per cent reduction of mosquitoes was obtained by the spraying of June 14 and 80 per cent control was indicated for at least 7 days. Mosquito populations began increasing near the outer borders shortly after spraying, but the main part of the post remained nearly free of annoyance for almost a week. At the time of the second application, June 25, the populations were only about one-third of those present before the first spraying.

Table 1.—Adult mosquito reduction obtained at Ladd Field with 0.1 pound of DDT per acre, applied with a C-47 airplane. Alaska, 1948.

Test Section	Number of Counting Stations	Average Landing Rate Before Spraying	Per Cent Reduction after (Days)—					
			1	2	4	6	7	8*
First Application, June 14, 1948								
Birch Hill (6 square miles)	23	32	98	94	92	94	88	91
Tanana (24 square miles)	13	10	94	91	78	95	44	76
Second Application, June 25, 1948								
Birch Hill	23	8	32[1]					
Tanana	11	13	94					

* Counts made in morning after an all night rain.
[1] The wind in the Birch Hill section was approximately 15 miles per hour at the time of spraying, which dropped to 5 miles per hour in the Tanana section during spraying.

The second application was not as effective as the first, probably because the wind increased from a slight breeze to approximately 15 miles per hour during the spraying of the Birch Hill section. The resulting control in this area was only 32 per cent. The wind dropped to 5 miles per hour during the spraying of the Tanana section and a 94 per cent control was obtained. Since the Birch Hill section represented only one-fifth of the sprayed area, weighted percentage would show 81 per cent control over the whole area.

EIELSEN FIELD TESTS.—The area treated is bounded on one side by a long line of hills 200 to 300 feet high, and on the opposite side by the Tanana River. The terrain is very flat and, in general, similar to that around Ladd Field except that some areas have a heavier stand of spruce.

The area sprayed, which included the air field, comprised a total of approximately 25 square miles, 5 by 5 miles. Two test applications were made at this base, one on the night of June 15 and the other on the night of June 24. Subsequently, the area received an additional routine spraying by the Area plane.

The data, table 2, Subsequently, the area received an additional routine spraying by the Area plane.

The data, table 2, showed that the first spraying of Eielsen Field gave a 95 per cent reduction and 91 per cent control was indicated after 5 days. Adult infiltration occurred rapidly and by the seventh day the reduction was only 61 per cent. The second treatment of Eielsen Field, on June 24, resulted in only 85 per cent reduction of adult mosquitoes. Failure to achieve higher control in this operation may have been due to the use of old DDT solutions (20 per cent DDT, 15 per cent chlorinated camphene, and 65 per cent fuel oil).

Table 2.—Adult mosquito reduction obtained at Eielsen Field with 0.1 pound of DDT per acre applied with a C-47 airplane. Alaska, 1948.

Number of Counting Stations	Average Landing Rate Before Spraying	Per Cent Reduction After (Days)—				
		1	2	5	6	7
First Application, June 15, 1948						
31	60.7	95	94	91	78	61
Second Application, June 24, 1948						
30	21.4	85				88[1]

[1] Counts were made in the morning after several days' rain.

BIG DELTA AIR FIELD TESTS.—The treated area is bounded on one side by a high escarpment which leads to the Tanana River valley and on the opposite side by a wide river flood plain. The terrain is moderately flat with little marsh land. Most of the area is covered with low shrubs, but interspersed with fairly dense clumps of spruce and quaking aspen.

The area sprayed, including the air field, was approximately 2 by 2 miles. Two test applications were made, one with 0.1 pound per acre on the night of June 16,

and one with 0.4 pound per acre on June 23. Subsequently an area of about 24 square miles, including the above, was resprayed by the Area plane.

Mosquito population counts, table 3, showed a 83 per cent reduction 24 hours after the spraying with 0.1 pound per acre, but after 48 hours a reduction of only 72 per cent was indicated. Seven days after the spraying mosquitoes were more numerous than before treatment.

Table 3.—Adult mosquito reductions obtained at Big Delta with DDT applied with a C-47 airplane. Alaska, 1948.

Number of Counting Stations	Average Landing Rate Before Spraying	Per Cent Reduction After				
		12 Hours	24 Hours	36 Hours	48 Hours	168 Hours
First Application, June 16, 1948, 0.1 Pound per Acre						
10	12.3		83		72	
Second Application, June 24, 1948, 0.4 Pound per Acre						
13	14.3	96	91	94	82	66

Results of the second spraying of Big Delta air field with 0.4 pound per acre indicated reductions of 96, 91, 94, and 83 per cent after 12, 24, 26, and 48 hours, respectively. Seven days after treatment the reduction was only 66 per cent.

Repeater Station, located only a short distance from Big Delta, was also sprayed with 0.4 pound per acre. The per cent reduction is tabulated below.

Number of Counting Stations	Average Landing Rate Before Spraying	Per Cent Reduction (Hours After Spraying)—				
		12	24	36	48	168
14	25.5	93	93	95	88	60

Dosage Study Tests.—Seven plots, each 3 square miles in area, were treated with two dosages of DDT, three with 0.05 and four with 0.025 pound per acre. In addition, one plot of 1 square mile and another of 4 square miles were treated with 0.4 pound per acre. All of these plots were flat and covered with a moderately dense growth of spruce. The results of these tests and those of the large-area tests are summarized in table 4, so that a comparison of effectiveness can be made between various dosages of DDT.

In the small-area tests a mean reduction of 39 per cent resulted from the 0.025-pound dosage, 80 per cent from the 0.05-pound dosage, and 92 per cent from the 0.4-pound dosage. The 0.4-pound-per-acre dosage gave reductions of 82 and 88 per cent at 48 hours, and 66 and 60 per cent at 7 days. In the 7 large-area tests, a dosage of 0.1 pound per acre gave a mean reduction of 83 per cent. By excluding the one test at Birch Hill which was made under unfavorable conditions, the mean reduction for the 0.1-pound dosage would be 92 per cent. Under favorable conditions, therefore, an application of 0.1 pound of DDT would seem adequate for practical control operations.

Infiltration Studies.—An effort was made to determine the rate of infiltration of mosquitoes into a sprayed area from surrounding unsprayed areas. Eielsen Field was selected for this test. The area sprayed was 5 miles square, as described previously in this report. Landing counts were made at 30 stations, 800 feet apart, across the treated area before spraying, and on the first, second, fifth, sixth, and seventh days after spraying.

Data from these observations are given in table 5.

Mosquitoes moved into the sprayed area more rapidly from the south side of the plot. The reason for this is not known,

Table 4. Adult mosquito reduction obtained in Alaska when applied at the rate of one-half pint of solution per acre.

Dosage of DDT (Pounds per Acre)	Plot Area (Square Miles)	Average Number of Mosquitoes (Landing Rate) at the Counting Stations Before Spraying	Per Cent Reduction 24 Hours After Spraying
0.025	3	29.5	60
	3	32.5	64
	3	25.0	17[1]
	3	10.5	14[1]
		Average 24.4	39
.05	3	19.8	85
	3	45.5	82
	3	24.7	73
		Average 30.0	80
.1	6	32	98
	24	10	94
	6	8	32[1]
	24	13	94
	25	60.7	95
	25	21.4	85
	4	12.3	83
		Average 22.5	83
.4*	4	14.5	91
	1	25.5	93
		Average 20	92

* Two pints of 20 per cent DDT applied per area.
[1] Low kill due to excessive wind during spray operation.

Table 5.—Mosquito infiltration into large sprayed area from surrounding unsprayed area. Eielsen Field, Alaska, June 15, 1948.

Distance from Center of Ground Area (Feet)	Number of Mosquitoes Before Spraying	Per Cent Reduction After				
		1 Day	2 Days	5 Days	6 Days	7 Days
0	100	100	98	99	90	90
800	100	96	100	100	70	88
1,600	88	100	100	100	82	76
2,400	94	99	100	97	83	39
3,200	109	100	97	93	90	51
4,000	176	99	98	89	87	79
4,800	148	93	96	93	84	62
5,600	171	97	95	95	83	56
6,400	90	100	99	87	52	31
7,200	126	91	95	87	77	68
8,000	97	96	90	80	34	71
8,800	147	100	95	87	74	76
9,600	129	94	88	89	83	63
10,400	165	97	95	87	77	50
11,200	204	77	83	82	82	65

although the terrain and flora of this area indicate a better breeding area, hence the natural population would be larger on that side of the field.

It will be noted that considerable protection was still evident on the fifth day and some on the seventh in the center of the plot.

From these studies, it is apparent that in an area like Eielsen Field spraying 25 square miles is too small an area to insure lasting protection to a military installation and subsequent sprayings are necessary.

DISCUSSION AND CONCLUSIONS.—One of the main objectives of the season was to determine how large an area must be treated to prevent reinfestation following a single treatment. The answer to this objective was not realized, but it was learned that a 2.5 to 3 mile radius is inadequate for Alaska. Fair relief from annoyance, however, can be realized for from 5 to 7 days when areas of this size are treated. It is necessary to use repeat treatments to provide protection for a season and from this year's experience it appears that there must be at least four sprayings. Even when DDT is applied at the rate of 0.4 pound per acre by air, a radius of 1 mile will provide protection for only 24 to 48 hours.

The dosage studies show that 0.1 pound of DDT per acre is the dosage that is practical and that little is to be gained with four times this rate of application.

SUMMARY.—Large-scale spray tests in Alaska showed that the infiltration of mosquito adults into plots 24 to 30 square miles in area is sufficiently rapid that the plots must be re-treated about every 7 to 10 days during the peak of the mosquito season. When only 4 square miles were treated, infiltration of annoying numbers of mosquitoes occurred within 48 hours. Fair protection of the large area was obtained with four sprayings during the season. The mean initial reduction with dosages of 0.4, 0.1, 0.05, and 0.025 pound of DDT per acre were, respectively, 92, 83, 80, and 39 per cent. Except for one test, under unfavorable wind conditions, the average reduction for the 0.1 pound dosage was 92 per cent instead of 83 per cent. The dosage of 0.1 pound of DDT is considered adequate if applied under suitable wind conditions.

SECOND INTERNATIONAL CONGRESS OF CROP PROTECTION

The Second International Congress will take place in London from 21st–28th July, 1949,

The Congress will be organized in 6 Sections for the reading of papers and discussions as follows:

Section 1—Insecticides.
Chairman: C. T. Gimingham, O.B.E., B.Sc., F.R.I.C.
Secretary: J. T. Martin, Ph.D., B.Sc., A.R.I.C. Plant Pathological Laboratory.

Section 2—Fungicides.
Chairman: Professor W. Brown, M.A., D.Sc. F.R.S.
Secretary: W. C. Moore, M. A. Plant Pathological Laboratory.

Section 3—Plant Growth Regulators.
Chairman: M. A. H. Tincker, M.A., D.Sc., F.L.S.
Secretary: H. A. Stevenson, B.Sc., Ph.D., A.R.I.C. Boots Pure Drug Co., Station St., Nottingham.

Section 4—Toxicology of crop protection substances
Chairman: Professor G. R. Cameron, D.Sc., M.B., B.S., F.R.S.
Secretary: J. M. Barnes. Toxicology Research Unit, Chemical Defense Experimental Station, Porton, Nr. Salisbury, Wilts.

Section 5—Methods of application.
Chairman: E. Holmes, M.Sc., Ph.D., A.R.I.C.
Secretary: H. G. Kearns, B.Sc., Ph.D. Research Station, Long Ashton, Nr. Bristol.

Section 6—Analytical methods and standardization
Chairman: H. Martin, D.Sc.
Secretary: R. L. Wain, M.Sc., Ph.D., F.R.I.C.

In addition to the Meetings of Sections there will be Congress Lectures and visits to Research Stations and Laboratories.

Some Host Relationships of Long Island Ticks[1]

D. L. Collins, R. V. Nardy, and R. D. Glasgow

On Long Island, New York, and in other parts of the eastern United States the chief vector of Rocky Mountain spotted fever to man is the tick *Dermacentor variabilis* Say.

Although most of the other species of ticks that occur on Long Island bite man rarely or not at all, they may be a factor in transmitting the disease organism, a *Rickettsia*, from one wild host to another.

In the course of the work on tick and spotted fever control on Long Island, a considerable number of wild mammals and birds have been taken and examined for ticks. The resulting data are significant in several ways, and include some new host records. This paper is a summary of information gathered in 1946 and 1947 on tick-host relations.

Excepting most of the *Dermacentor variabilis* adults and nymphs, which were separated and identified by Collins & Nardy, the ticks collected from vertebrate hosts in 1946 were identified by Mr. George Anastos through the courtesy of Dr. Joseph Bequaert, Curator of Insects, Museum of Comparative Zoology, Harvard University. For all new records, the identification was verified by Dr. Bequaert. These identifications, and the corresponding host records supplied by the New York State Science Service, have been published by Mr. Anastos (1947). The ticks collected from vertebrate hosts in 1947 were identified by Mr. Nardy, and verified by Mr. Anastos and Dr. Bequaert.

In the course of these studies of tick-host relationships through 1946 and 1947, a total of 275 mammals representing 16 species, and 74 birds representing 26 species were taken and searched for ticks. From these 367 animals, 2801 ticks representing 7 species were collected.

The seven species are: *Dermacentor variabilis* (Say), *Haemaphysalis leporis-palustris* Packard, *Ixodes cookei*, Packard, *Ixodes Dentatus* Neumann, *Ixodes muris* Bishopp & Smith, *Ixodes scapularis* Say and *Ixodes marxi* Banks.

The hosts of all of the species of ticks thus far found in the course of this work on Long Island are as follows: *Dermacentor variabilis* (Say): White-footed mouse *Peromyscus leucopus* Rafinesque; meadow mouse, *Microtus pennsylvanicus* Ord; Eastern skunk, *Mephitis mephitis* (Peale & Beauvois); Raccoon, *Procyon lotor* (L); opossum, *Didelphia virginiana* Kerr; short-tailed shrew, *Blarina brevicauda* (Say); long-tailed shrew; *Sorex cinereus* Kerr; jumping mouse *Zapus hudsonius* (Zimmerman); gray squirrel, *Sciurus carolinensis* Gmelin; house rat, *Rattus norvegicus*, red fox; *Vulpes fulva* (Desmarest); and man.

Haemaphysalis leporis-palustris Packard: Eastern cottontail, *Sylvilagus floridanus* (Allen); white-footed mouse; brown thrasher, *Toxostoma rufum rufum;* and cuckoo, *Coccyzus americanus.*

Ixodes cookei Packard: Red fox; brown weasel, *Mustela cicognanii cicognanii* Bonaparte.

Ixodes dentatus Neumann: Eastern cottontail, white-footed mouse, raccoon and man.

Ixodes marxi Banks: Gray squirrel.

Ixodes muris Bishopp & Smith: White-footed mouse; Eastern skunk; long-tailed shrew; short-tailed shrew; gray squirrel; red fox; Virginia deer, *Odocoileus virginianus* Bodaert; raccoon; chipmunk, *Tamias striatus* (L.); house rat; Eastern cottontail, catbird, *Dumatella carolinensis;* song sparrow, *Melospiza melodia;* towhee, *Pipilo erythrophthalamus;* American robin, *Turdus migratorius;* and brown thrasher.

Ixodes scapularis (Say): Eastern cottontail, Eastern skunk and man.

These data from the Long Island collections disclosed several previously unrecorded tick-host relationships. From the 1946 collections Mr. Anastos (1947) writes:

"During this (Long Island) survey *Ixodes muris* has been observed and recorded for the first time from the long-tailed shrew, gray squirrel, Eastern cottontail rabbit, red fox, chipmunk, raccoon, skunk, Virginia deer, red-eyed towhee, catbird, eastern or American robin, and brown thrasher. This makes 12 new hosts for the larval and nymphal forms of *Ixodes muris* Bishopp & Smith. Also recorded for the first time was the larval form of

[1] Presented at the Chicago Meetings, Dec.

Dermacentor variabilis (Say) from the long-tailed shrew. This represents the first record of any species of tick taken from the long-tailed shrew in the Northeastern United States."

The continuation of this survey of tick-host relationships on Long Island in 1947 added three more apparently new records. These are the collection of *Ixodes scapularis* from the eastern skunk and *Haemaphysalis leporis-palustris* from the yellow-billed cuckoo and white-footed mouse.

Thousands of specimens of adult *Dermacentor variabilis* were collected by dragging, but the only other species captured in this way, or in any other way except from the hosts, was *Ixodes scapularis*. Of this species, 10 males and 4 females were taken in 1946 by dragging at Montauk Point, and 1 female was taken by dragging near Southampton in 1947.

Dermacentor variabilis, in the adult form was the predominant species on red fox and raccoon. The red fox had the highest total average of ticks per host (103) and also the highest average of *D. variabilis* per host (54). The only adult tick of any species found on the red fox was *D. variabilis*.

The immature stages of *Dermacentor variabilis* were found largely on the white-footed mouse and the meadow mouse, the white-footed mouse apparently being the most important, at least in the areas studied.

Fifty-four meadow mice had 9 immature *Dermacentor variabilis*; whereas 111 white-footed mice had 98 immature *D. variabilis*. Thirty shrews had 5 *D. variabilis* larvae; 46 rabbits had 2 *D. variabilis* nymphs; 13 squirrels had 2 *D. variabilis* nymphs; 1 house rat had 1 *D. variabilis* nymph; 1 jumping mouse had 1 *D. variabilis* nymph.

There was a much higher incidence of *Dermacentor variabilis* on animals collected east of the Shinnecock canal. All evidence indicates that this is the true condition even though the numbers of animals captured in the two areas was disproportionate, the larger number having been taken in the eastern area.

Approximately the same number of rabbits were taken east and west of the Shinnecock canal; that is, on the Montauk Peninsula in the east, 20 rabbits were captured, and in the Islip and Smithtown areas to the west, 26 rabbits were taken. It is interesting to note that in the western section, of 462 tick specimens found on rabbits, 409 were *Ixodes dentatus*, and that this is the only instance where *I. dentatus* was the predominant species. On the rabbits collected east of the canal, of 430 tick specimens 164 were *Haemaphysalis leporis-palustris*, 133 were *I. dentatus*, 127 were *I. muris*, 1 was *I. scapularis* and 5 were *Dermacentor variabilis*.

On seven gray squirrels collected west of the canal the only ticks found were *Ixodes marxi*, 37 specimens, whereas on the six squirrels from the eastern section, 158 specimens of *I. muris* and 3 specimens of *Dermacentor variabilis* occurred, with no *I. marxi*.

Although *Dermacentor variabilis* would appear to be the most common species on Long Island to the casual observer who judges only by the number he picks up on his clothing, it was not the most common species actually found on the mammals, and did not occur at all on birds. *Ixodes muris* was the prevalent species on mammals, being predominant on white-footed mouse, meadow mouse, shrews, gray squirrel, house rat, eastern skunk, chipmunk, Virginia deer, and on the birds. With the exception of three specimens of *Haemaphysalis leporis-palustris*, *I. muris* was the only species found on birds. Of these three specimens of *H. leporis-palustris*, one was taken from a brown thrasher from Montauk Point and two from a yellow-billed cuckoo from Red Cedar Point (Hampton Bays).

The red fox had an average of 49 immature ticks per host, an average of 44 per host being *Ixodes muris*, and the remaining 5 per host being *I. cookei*. The majority of these immature ticks were found attached to the tender skin between the toes. There were no larvae or nymphs of *Dermacentor variabilis*.

The eastern skunk and the gray squirrel also proved to be important hosts of the immature stages with an average of 47 nymphs and larvae per host for the skunk, all of which were *Ixodes muris*, and 15 nymphs and larvae per host for the squirrel, 12 of which were *I. muris*, the remaining 3 being *I. marxi*. With the skunks and the squirrels the immature stages were not largely confined to the feet but were found between the shoulders and at the axilla.

No adult ticks of any species were found on birds. Further, adults were found on

only an extremely small percentage of mice. Many of the larger mammals were apparently acceptable to both the immature and adult stages.

Ticks were entirely absent from the following species of birds: Chipping sparrow, *Spizella passerina passerina;* unidentified sparrow; kingbird, *Tyrannus tyrannus;* herring gull, *Larus argentatus;* black duck, *Anas rubripes;* English sparrow, *Passer domesticus domesticus;* green heron, *Butorides virescens virescens;* horned lark, *Eremophila alpestris;* purple grackle, *Quiscalus quiscula;* redstart, *Setophaga ruticilla;* common tern, *Sterna hirundo hirundo;* red-eyed vireo, *Vireo olivaceus;* yellow warbler *Dendroica petechia;* northern yellowthroat, *Geothylypis trichas brachidactyla;* unidentified warbler; ring-necked pheasant, *Phasianus colchicus torquatus;* pigeon hawk, *Falco columbarius columbarius;* crow, *Corvus brachyrhynchos;* mallard duck *Anas platryrhynchos platyrhynchos;* and red-winged blackbird, *Agelaius pheoniceus.*

The flying squirrel, *Glaucomys volans volans,* was the only mammal that was completely free of ticks. This is not surprising considering how little time a flying squirrel spends on the ground in areas where it could acquire ticks. Many birds, on the other hand, spend considerable time on the ground or in thickets where they could easily become infested. It is probable that a larger series of birds, especially of those that often frequent the ground, would show that many of those listed above as "tick free," often acquire them. This is already known to be true of the pheasant in other sections.

One larva and one nymph of an unidentified species of *Ixodes* were found attached to the arm of one of the authors. Both of these specimens probably came from a white-footed mouse which had been examined earlier the same day. Engorgement had not occurred, and man could not, perhaps, be considered a "host" on the basis of such a record.

The shrews furnished interesting records, and it is possible that they are actually more important than they appeared since every shrew examined was dead in the trap when found, leaving the possibility that ticks may have left the host shortly after its death, and before it was brought in for examination.

ADDITIONAL OBSERVATIONS ON *Dermacentor variabilis.*—In 1946, along the Montauk highway, adult ticks, *Dermacentor variabilis,* were found in especially large numbers in the grass around piles of horse manure.

On another occasion, dozens of specimens were found on the greasy skull of a sheep which had apparently been thrown out in the grass, on the north side of the dunes along the beach near Easthampton. Many more were found on the grass blades around and overhanging the skull.

In 1947 a concentration of adults was noted on the door and door jamb of a small pumphouse situated in the heath area at Hither Hills.

On another occasion, in Bay Shore, hundreds of adult ticks were found on the timber sides, and in the grass adjacent to, a small boat slip leading from one of the canals. There were comparatively few ticks elsewhere in the vicinity.

An interesting observation was the finding of a larva of *Dermacentor variabilis* attached to an engorging nymph of the same species which was attached to a white-footed mouse captured at Montauk Point in August, 1947. The larva had its rostrum inserted into the body of the nymph immediately behind the second pair of legs, on the right lateral surface.

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Residual Toxicity of DDT Analogs and Related Chlorinated Hydrocarbons to House Flies and Mosquitoes[1]

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The long-lasting residual toxicity of DDT to insects has made it of special value in the control of house flies and malaria mosquitoes. A considerable number of DDT analogs have been tested, chiefly as sprays and dusts, against different species of economic insects, and a few of the compounds have shown a high degree of toxicity to some species. As a residual toxicant to house flies and mosquitoes, however, apparently only one, dichlorodiphenyl dichloroethane[3], has been reported upon. Sweetman (1947) found that this analog was about equal to DDT in residual effectiveness when applied to livestock for the contol of horn flies, stable flies, and house flies. Fay *et al.* (1947) showed that 200-mg.-per-square-foot deposits of dichlorodiphenyl dichloroethane were effective for 8 weeks against mosquitoes, but in 26 weeks were less effective than DDT at the same dosage. Against house flies this compound showed little initial toxicity.

The present paper contains a report on the results of laboratory residue tests with 21 analogs of DDT and 19 other new chlorinated hydrocarbons.

SCREENING TESTS.—Preliminary screening tests were made with the 40 compounds to eliminate those noneffective as residual treatments. These tests were made by confining insects on treated cloths under half-sections of petri dishes. Four 6-inch squares of 8.2-ounce cotton twill were impregnated with an acetone solution of each analog at the rate of 100 mg. of active ingredient per square foot. When dry, the cloths were stapled to plywood boards to provide a rigid testing surface. The tests were conducted with laboratory-reared insects in a room maintained at 80° F. and 75 per cent relative humidity. One week after treatment 24-hour exposures were made with adult yellow-fever mosquitoes, *Aëdes aegypti* (L.), and house flies, *Musca domestica* L., on two of the four panels and on the other two panels the following day. Approximately 50 2-day-old mosquitoes and 40 4-day-old flies were exposed on each panel. A pad of cotton soaked in a honey-and-water solution provided food and water for the insects.

The following compounds caused less than 90 per cent mortality of either flies or mosquitoes in 24 hours and were not tested further:

Benzophenone, 4,4′-dichloro-
Ethane, 2-biphenylyl-1,1,1-trichloro-2-phenyl-
Ethane, 2,2-bis(*p*-acetoxyphenyl)-1,1,1-trichloro-
Ethane, 2,2-bis(*p-tert*-butylphenyl)-1,1,1-trichloro-
Ethane, 1,1-dibromo-2,2-bis(*p*-bromophenyl)-
Ethane, 1,1-diphenyl-
Ethane, 1,1,1-trichloro-2,2-bis(5-chloro-2-methoxyphenyl)-
Ethane, 1,1,1-trichloro-2,2-bis(3,5-dichloro-2-methoxyphenyl)-
Ethane, 1,1,1-trichloro-2,2-bis(3,5-dichloro-4-methoxyphenyl)-
Ethane, 1,1,1-trichloro-2,2-bis(2,5-diethoxyphenyl)-
Ethane, 1,1,1-trichloro-2,2-bis(3,4-dimethoxyphenyl)-
Ethane, 1,1,1-trichloro-2,2-diphenyl-
Ethylene, 2,2-bis(*p*-bromophenyl)-1,1-dichloro-
Ethylene, 1,1-dichloro-2,2-diphenyl-
Ethylene, 1,1-diphenyl-
Mesitylene, *alpha, alpha, alpha, alpha′, alpha′, alpha′, alpha″, alpha′, alpha″* -nonachloro-
Methane, bis(3-chloro-6-hydroxyphenyl)-
Methane, bromobis(*p*-chlorophenyl)-
Methane, (*o*-chlorophenyl)(*p*-chlorophenyl)-
Methane, dichloro(*p*-chlorophenyl)phenyl-
Methane, diphenyl-
Methanol, bis(*p*-chlorophenyl)-
Sulfide, bis(*p*-chlorophenyl)-
Sulfoxide, bis(*p*-chlorophenyl)-
Toluene, *alpha, alpha, alpha*, 2,4-pentachloro-
Toluene, *alpha, alpha, alpha*, 3,4-pentachloro-
Toluene, *alpha, alpha, alpha*, 3-tetrachloro-
Toluene, *alpha, alpha, alpha*-trichloro-
o-Xylene, *alpha, alpha, alpha, alpha′, alpha′, alpha′*-hexachloro-
m-Xylene, *alpha, alpha, alpha, alpha′, alpha′, alpha′*-hexachloro-
p-Xylene, *alpha, alpha, alpha, alpha′, alpha′, alpha′*-hexachloro-

COMPARISON OF BEST ANALOGS.—Further comparisons of the nine best materials (all analogs of DDT) were made on treated cloths, which were tested 1 week after treatment and at 4-week intervals thereafter. The testing procedure was identical to that described for the screening tests, except that the insects were exposed for only 2 hours instead of 24. At the end of the exposure period they were immobilized with carbon dioxide to facilitate their transfer to clean screen-wire holding cages. A pad of cotton soaked in a honey-and-water solution was placed on the screen holding cage to provide food and water for the insects. Records were made of the 2-hour knock-down and the 24-hour mortality.

The results of tests with DDT and nine

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[2] The authors acknowledge the advice and assistance of W. V. King, in charge of the Orlando, Fla., laboratory of this Bureau, and the assistance of Fred R. Shillcutt and George Brymer in the conduct of the work.

[3] *DDD* or *TDE.*

Table 1.—Comparative knock-down and mortality of *Musca domestica* and *Aëdes aegypti* exposed for 2 hours to residues of DDT analogs applied to cloth panels at the rate of 100 mg. per square foot. (Averages of tests on 4 panels. For the 4th and 8th weeks, because of excessive check mortality on 1 day, the averages shown are from 2 panels only.)

Material	Age of Residue (Weeks)	*Aëdes aegypti*		*Musca domestica*		
		Per Cent Knock-down in 2 Hours	Per Cent Mortality in 24 Hours	Per Cent Knock-down in 2 Hours	Per Cent Mortality in 24 Hours	
			Both Sexes		Male	Female
Ethane, 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)-[DDT], byproduct oils: Not distilled	1	100	100	19	95	75
	4	96	100	96	100	100
	8	78	100	47	100	100
	12	69	99	12	97	45
	16	43	98	0	80	28
	20	27	87	0	24	0
	24	0	18	0	14	0
Distilled	1	98	100	1	84	61
	4	83	97	0	79	2
	8	38	98	1	83	3
	12	26	91	0	25	0
	16	23	78	0	75	0
Ethane, 1,1,1-trichloro-2,2-bis(*p*-tolyl)-	1	100	100	52	100	91
	4	90	95	5	89	32
	8	60	62	1	43	2
Ethane, 1,1,1-trichloro-2-(*p*-chlorophenyl)-2-phenyl-	1	100	100	39	41	43
	4	53	91	0	14	0
	8	2	52	0	5	0
	12	2	29	0	2	0
Ethane, 1,1-dichloro-2,2-bis(*p*-chlorophenyl)-, [TDE]	1	43	99	87	100	100
	4	5	46	1	87	8
	8	3	31	1	75	10
Ethane, 1,1,1-trichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)-, [*o,p*-DDT)	1	6	87	0	52	23
	4	0	46	0	27	13
	8	2	12	0	15	0
Ethane, 1,1,1-trichloro-2,2-bis(*p*-fluorophenyl)-	1	67	81	0	54	13
	4	0	16	0	0	6
	8	0	3	0	0	0
Ethane, 1,1,1-trichloro-2,2-bis(*p*-methoxyphenyl)-, [methoxychlor]	1	63	69	51	99	93
	4	1	22	90	100	100
	8	0	3	96	100	98
	12	9	29	97	100	96
	16	13	34	81	100	74
	20	10	34	82	100	51
	24	0	10	58	96	20
	28	18	26	77	99	51
	32	0	17	70	93	62
Ethane, 2,2-bis(*p*-bromophenyl)-1,1,1-trichloro-, [*p*-bromo-DDT]	1	1	59	30	100	100
	4	0	20	15	100	100
	8	0	9	8	100	73
	12	2	34	1	82	38
Standard: Ethane, 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)-, [DDT]	1	100	100	100	100	100
	4	88	100	100	100	100
	8	85	100	99	100	100
	12	97	100	98	100	100
	16	78	100	58	100	85
	20	88	99	63	100	92
	24	62	89	34	100	88
	28	88	99	14	99	71
	32	52	99	15	100	75

of the analogs are given in table 1. Initial tests on week-old residues showed that four compounds in this group were as toxic as DDT to adult *Aëdes aegypti*. Five others gave mortalities ranging from 69 to 99 per cent. The best compound was a sample of "DDT byproduct oils," the composition of which is unknown. This material caused 100 per cent mortality for 8 weeks and was highly effective for 16 weeks. The standard DDT residue gave 100 per cent kill of mosquitoes for 16 weeks and was 99 per cent effective after 32 weeks.

square foot. A small electric sprayer with a DeVilbiss nozzle was used to treat the boards. House flies confined under petri dishes were exposed on these treated boards for 30 and 120 minutes on 2 days the first, fourth, and eight weeks after treatment.

In tests against house flies (Table 2) no significant differences in knock-down or mortality were shown by the three treatments on the initial exposures. After 4 weeks the B sample of methoxychlor and DDT were about equal in toxicity, and both were markedly superior to the A

Table 2.—Comparative toxicity to house flies of two commercial methoxychlor wettable powders and DDT. Average of 6 tests, 1 on each panel, on 2 consecutive days.

Material	Age of Residue (Weeks)	30-Minute Exposure			120-Minute Exposure		
		Per Cent Knock-down in 2 Hours	Per Cent Kill in 24 Hours		Per Cent Knock-down in 2 Hours	Per Cent Kill in 24 Hours	
			Male	Female		Male	Female
Methoxychlor:							
Sample A	1	99	100	100	100	100	100
	4	55	85	63	84	100	97
	8	31	75	28	82	92	98
Sample B	1	100	100	100	100	100	100
	4	100	100	98	100	100	100
	8	76	96	84	94	100	98
DDT	1	100	100	100	100	100	100
	4	96	99	98	94	100	100
	8	12	95	46	70	100	95

Four of the analogs of DDT were highly toxic to house flies as week-old residues, but only methoxychlor (the methoxy analog) retained a high degree of toxicity as long as 12 weeks. This analog was the only one that showed greater toxicity to house flies than to mosquitoes. The sample of "DDT byproduct oils," which was the most effective against mosquitoes, gave 100 per cent kill of house flies after 8 weeks, but was ineffective after 12 weeks. By comparison, DDT residues provided 100 per cent mortality for 12 weeks and remained highly effective for 24 weeks.

COMPARISON OF TWO METHOXYCHLOR SAMPLES.—Two proprietary samples of 50 per cent wettable methoxychlor were compared with a standard 50 per cent wettable DDT. One per cent suspensions of each of these materials were sprayed on three plywood boards at the rate of 100 mg. of the active ingredient per

sample of methoxychlor. After 8 weeks the B sample, in the 30-minute exposure, gave definitely greater knock-down of both sexes and greater kill of female flies than DDT. The A sample was relatively ineffective at this time.

SUMMARY.—Laboratory tests were conducted against house flies, *Musca domestica* L. and yellow-fever mosquitoes, *Aëdes aegypti* (L.), with 21 analogs of DDT and 19 other new chlorinated hydrocarbons. Nine of the analogs, as dry residues, caused 90 per cent or higher kills of one or both species of insects at exposures of 24 hours, and were tested further at exposures of 2 hours. Only four of them caused 100 per cent mortality of mosquitoes when they were a week old and none were as long lasting as DDT. The best material was a sample of "DDT byproduct oils," the composition of which is unknown. It provided 100 per cent

mortality for 8 weeks, as compared with 16 weeks for DDT.

Four of the analogs were highly toxic to house flies during the first few weeks, and the best of these was methoxychlor (the methoxy analog). It remained effective for as long as 12 weeks, and was the only one exhibiting greater toxicity to house flies than to mosquitoes. DDT residues were highly effective for 24 weeks.

Two proprietary samples of 50 per cent wettable methoxychlor were compared with a standard 50 per cent wettable DDT powder to determine their effect on house flies. One of the methoxychlor samples was significantly more toxic than DDT at the end of the eighth week. The other sample was markedly inferior.

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The Chlorinated Hydrocarbon Content of Milk from Cattle Sprayed for Control of Horn Flies

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The presence and quantity of chlorinated hydrocarbons in milk produced by cows sprayed with commercial preparations containing these materials were investigated during the summer of 1947. Cattle were sprayed for control of horn flies, *Siphona irritans* (L.), at 11 commercial dairies in Kerr and Gillespie Counties, Texas. Samples of milk from these cows were taken at regular (7-day) intervals and analyzed for organic chlorine or specific insecticide compounds. The purpose of this report is to present results of findings in these investigations. No studies were made to interpret the significance of the results and to draw conclusions relative to the use of or potential toxicity hazards of the various insecticides.

The cows were typical farm dairy herds, producing for the local fluid-milk markets. The herds contained from 14 to 64 cows. Most of the animals were high-grade Jersey. Milking was done by machine, and ordinary precautions were observed to prevent contamination of the milk.

SPRAYING PROCEDURE.—All herds were sprayed with water suspensions of commercially formulated wettable powders containing chlorinated hydrocarbons. The same insecticide and concentration were used at each dairy throughout the season.

The intervals between sprayings were governed by the recurrence of an annoying abundance of horn flies, according to the practice of dairymen. Horn flies were counted periodically. The dates of spraying are shown in table 1.

The spraying procedures were similar to those used in commercial practice. The cows were sprayed in the stanchions after the milking had been completed. A wheelbarrow-type power sprayer with agitator was used, with a 50-foot length of hose and a pressure of approximately 100 pounds per square inch at the pump. Two flat-spray nozzles were fixed about 8 inches apart on a broom-type assembly. The operator, holding the two nozzles in a vertical line, passed them along the side of the cow, wetting from the neck to the tail and from the back to a low line along the sides, but not the head, the belly, or the udder.

The amount of spray applied to one animal averaged approximately 2.2 quarts. With 0.5 per cent concentration this is equivalent to 10.3 grams of insecticide. Much of the spray ran off; so it is difficult to estimate the amount of insecticide retained on the hair.

[1] Dr. Radeleff is a member of the staff of the Bureau of Animal Industry and of the A.A.E.E.

Table 1 —Insecticides used and dates of spraying in the different dairies.

CONCENTRATION (per cent)	SPRAYING DATES (1947)
	DDT
0.5	5/15, 6/11, 7/29, 8/22
0.5	5/23, 6/16, 7/28, 8/22, 9/26
0.25	5/28, 6/12, 7/15, 8/5, 8/18, 9/9
0.25	6/24, 7/16, 8/7, 8/26, 9/4, 9/25
	2,2-bis-(p-chlorophenyl)-1,1-dichloroethane
0.5	5/23, 6/11, 7/15, 8/14, 9/9
0.5	5/15, 6/4, 7/18, 8/13, 9/5
	Methoxychlor
0.5	5/23, 6/11, 7/9, 8/18, 9/3
0.5	5/15, 6/4, 7/18, 8/8, 9/12
	Toxaphene
0.5	5/23, 6/17, 8/12, 9/10
0.5	5/15, 6/4, 8/5, 8/29
	Chlordan
0.5	5/15, 6/4, 8/5, 8/29

SAMPLING AND PROCESSING THE MILK.—Quart milk bottles were used for collecting milk samples. The bottles were thoroughly scrubbed with rain water and soap, rinsed, and dried. They were then capped, and one bottle was carried to each dairy every week. The dairyman placed in the bottle about 1 pint of milk, composite from one 10-gallon can, for a butterfat test. Another pint was placed in a screw-cap bottle and 1 ml. of formalin was added as a preservative. The samples were held in ordinary household refrigeration until packed and shipped by express to the Agricultural Research Center, Beltsville, Md., for analysis. Beginning June 30 the samples from cows sprayed with DDT were prepared at the Kerrville laboratory in duplicate in 50-ml. bottles and each was preserved with 0.5 ml. of formalin.

METHODS OF ANALYSIS.—The samples of milk from the cows that had been sprayed with chlordan chlorinated camphene, dichlorodiphenyl dichloroethane, and the methoxy analog of DDT were analyzed for their organic-chlorine content by a modification of the method recommended by Carter (1947). The samples of milk were extracted several times with a 3:1 mixture of ethyl ether and petroleum ether (Skelly B). The extracts were combined and then washed twice with water to eliminate inorganic and water-soluble chlorides. After treatment with isopropanol and metallic sodium, the reaction mixture containing the organic acids precipitated by sulfuric acid was cooled in the refrigerator before filtration in order to get a better separation. Extraction with a mixture of ethyl ether and petroleum ether was also carried out. Since blank samples were not always available, a constant correction of 0.18 mg. of chlorine was subtracted from the organic-chloride determinations. Determinations of organic chlorine in milk samples containing known added amounts of these materials have indicated 85 to 99 per cent recovery.

The samples of milk from the cows that had been sprayed with DDT and dichlorodiphenyl dichloroethane were tested for these compounds by the colorimetric method recommended for the determination of DDT in milk (Schechter *et al.* 1947). With some modifications this method can be utilized for the determination of these compounds in milk in amounts as low as 0.1 to 0.2 p.p.m.

RESULTS.—The results of the colorimetric determinations on samples of milk from the four dairies using DDT are shown in figure 1. Similar determinations on milk from the dairies sprayed with dichlorodiphenyl dichloroethane showed a maximum of 1.2 and an average of 0.4 p.p.m. in dairy No. 5, and a maximum of 1.1 and an average of 0.2 p.p.m. in dairy No. 6.

The results of the analyses for organic chlorine in milk from dairies using dichlorodiphenyl dichloroethane, the methoxy analog of DDT, chlorinated camphene, and chlordan are summarized in table 2.

Analyses before and after pasteurization of a few milk samples containing small amounts of DDT indicated that this process did not decompose the compound.

DISCUSSION.—The amounts of organic chlorine found in the milk from cows sprayed with chlordan, chlorinated camphene, and the methoxy analog of DDT were so small that they are not regarded as definitely indicating the presence of these compounds. Attempts to determine an increase in the water-soluble chlorides in milk due to metabolism of these compounds were not successful, since the natural chloride content of the aqueous

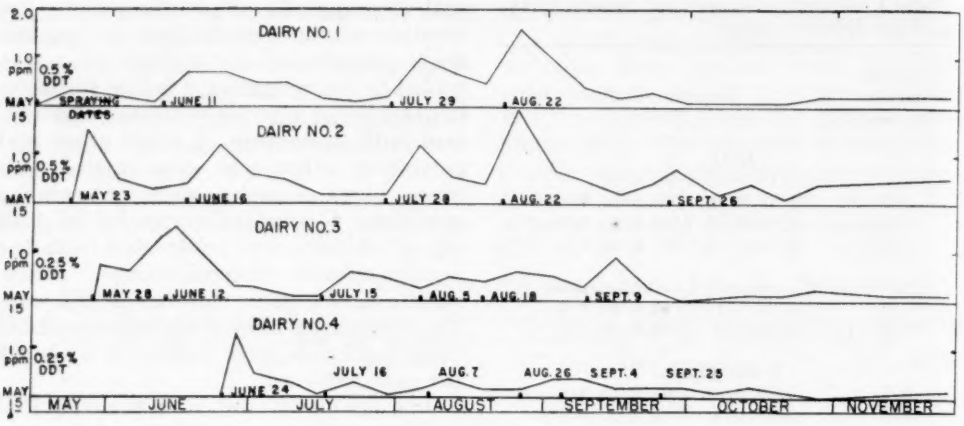

FIG. 1. DDT content of milk samples from cattle sprayed on dates indicated.

Table 2.—Organic-chlorine content in milk from dairies sprayed with several chlorinated hydrocarbons.

Insecticide	Dairy No.	Sampling Period[1]	Organic Chlorine, p.p.m.	
			Maximum	Average
Dichlorodiphenyl dichloroethane	5	May 26 to Nov. 20	2.1	0.5
	6	May 22 to Nov. 10	1.8	.2
Methoxychlor	7	May 26 to Oct. 27	0.6	0.1
	8	May 22 to Nov. 10	.1	.1
Toxaphene	9	May 26 to Oct. 27	.6	.1
	10	May 26 to Oct. 13	.2	.1
Chlordan	11	May 22 to Oct. 27	.8	.2

[1] At approximately 7-day intervals.

phase of the milk was relatively high. Determinations of the organic-chlorine content of milk containing DDT and the colorimetric determination of DDT in the same milk have given consistent results in previous investigations (Carter 1947, Schechter *et al.* 1947).

The results of these experiments indicate that DDT, dichlorodiphenyl dichloroethane and possibly chlordan were eliminated in the milk, but they give no conclusive indications with chlorinated camphene and methoxychlor.

The results with DDT confirmed those obtained by Howell *et al.* (1947), that some DDT was found in the milk of cows sprayed with this insecticide.

The presence of the compounds in the milk may be accounted for by one or all of the following possible methods of entry: Contamination of the milking equipment, mechanical transfer of the materials during hand milking, absorption through the skin of the animal, and ingestion from licking.—7-12-48.

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DDT Content of Milk from Cows Fed Pea Vine Silage Containing DDT Residues[1,2]

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The results of large-scale treatments of peas during 1946 with DDT aerosols and sprays have been reported by Ditman *et al.* (1947). The present paper gives the results of chemical analyses of DDT in vines and silage from fields treated with DDT sprays, dusts, and aerosols. It also gives the results of an experiment carried out to determine the DDT content in milk from cows fed silage from pea vines that had been treated with aerosols. Biological tests with house flies, *Musca domestica* L., were made with the milk samples to supplement the results obtained by chemical analyses.

Materials and Methods.—Applications were made during the first few days of May 1946. The dusts contained 1 per cent of DDT and 2 per cent of non-volatile solvent and were applied at the rate of 43 pounds per acre. The sprays for 1 acre were made by diluting in 100 gallons of water a stock solution containing 0.5 pound of DDT, 1 pint (450 ml.) emulsifier[3] chiefly di- and trimethylnaphthalenes, and 1.5 tablespoonfuls (22 ml.) of an aralkyl polyether alcohol. The aerosols contained 5 per cent of DDT and were applied at the rate of 10 pounds per acre. Dichlorodifluoromethane or methyl chloride was used as the propellant in these aerosols. The amounts of DDT applied per treatment in all formulations ranged from 0.4 to 0.5 pound per acre. All methods were effective against the pea aphid *Macrosiphum pisi* (Klth.) but the aerosols were slightly inferior to the emulsion sprays and to the methyl chloride-propelled aerosols.

Samples of pea vines, taken for analysis from several treated fields either shortly after treatment or shortly before harvest three to four weeks later, consisted of all plants cut at the ground level in two square-yard areas. In fields where samples were taken shortly after treatment and again near harvest the latter were taken from areas contiguous to those from which the first samples were taken.

The vines from fields that had been treated with DDT emulsion were placed in a silo on one farm and in a stack on another. The samples of silage for analysis from either the silo or the stack consisted of a mixture from 7 to 10 lots of 1 or 2 pounds each taken from different points at a given exposed level.

Another stack of silage was made from pea vines that had been treated with Freon-propelled DDT aerosols at the rate of 0.5 pound of DDT per acre. This stack included the crop from 700 acres of peas grown on several farms in the vicinity of the cannery. The treated fields had been harvested over a period of three weeks, four to five weeks after treatment. The samples of silage from this stack were composites taken as each of 50 barrels was being filled from the stack. These samples were fed to two 1200-pound Ayrshire cows for a 60-day period, beginning August 30. The cows were fed at the usual rate of 3 pounds of silage per 100 pounds of body weight. In addition to the silage, each cow received daily 15 pounds of mixed hay and 12 pounds of a 16-per cent protein grain concentrate. Both cows were producing milk at the rate of about 40 pounds each per day.

Weather Conditions.—Weather records for May, which covers generally the period between treatment and harvest, indicated mean, maximum, and minimum temperatures of 64°, 85°, and 40° F., respectively. The month had a total precipitation of 5.46 inches and 14 days in which precipitation exceeded 0.1 inch, with a maximum precipitation of 2.02 inches in one day.

Residues on Vines.—Chemical analyses for organic-chlorine residues on the pea vines and silage were made by the method recommended by Carter and Hubanks (1946). The analyses, which are summarized in table 1, showed considerable variation in the quantities of DDT

[1] A cooperative experiment by the U. S. Bureau of Entomology and Plant Quarantine and the University of Maryland.
[2] "Report of a study in which certain phases were carried on under the Research and Marketing Act of 1946."
[3] *Velsicol AR60.*

residue on vines with all methods of application. The largest amounts of DDT were found on vines treated with Freon aerosols when the atmospheric temperature was below 50° F. The high residues found on vines treated at these low temperatures were thought to have been due to increased particle size of the aerosols. These large particles not only resisted weathering but gave poor coverage and poor aphid control. No other factors were evident which would account for the variation in residues. The quantities of residue in samples from fields given the same treatment differed considerably. These differences may have been due in part to the density of growth at the time of treatment and to the proportion of growth present at the time of treatment and the subsequent new growth included in the sample.

Samples of silage taken in June from the stack and the silo containing pea vines that had been sprayed with emulsion showed very little DDT, whereas samples taken from the same locations in August did show some DDT. This discrepancy may have been due to a sampling error in such large masses of material. The samples from the silo were taken at a depth of about 4 feet, well below the zone of aerobic fermentation. At the time of collection the temperature of the ensilage was 182° F.

Silage from a stack of pea vines that had received the dust treatment showed no DDT.

Silage from pea vines that had been treated with Freon aerosols showed residues of approximately 8 to 18.7 p.p.m., on a dry-weight basis, when taken between August 7, 1946 and October 21, 1947. Although samples taken during October and November showed somewhat smaller residues, the January samples equaled the August samples, an indication that no deterioration had occurred during the five-month storage period. A comparison of the residues found in samples taken in October 1946 and 1947 indicated no appreciable deterioration during a 12-month storage period and that DDT remained in the ensilage for at least 17 months after harvest.

Wilson (1946*b*) has reported smaller residues in pea vine silage that has fermented than were present in the treated pea vines before they were cut. The differences could be due to nonuniformity in the stack.

Residues in Milk. Wilson *et al.* (1946*a*, *b*) have reported 15 p.p.m. of DDT in milk from cows consuming an estimated 1.48 to 1.84 grams of DDT daily, and a maximum of 44 p.p.m. in milk from a cow fed 24 grams of DDT daily for 5 months. According to Allen *et al.* (1946) pea vine silage from a field-dusted experimental plot contained less than 1 p.p.m. of DDT and no DDT was found in the milk of cows to which it was fed. Carter (1947) and Schechter *et al.* (1947) also reported that the milk from cows grazing on DDT-sprayed pastures and fed hay containing DDT residues contained up to 25 p.p.m. of DDT.

In this experiment composite samples of the silage fed to the two cows showed a DDT residue of 2.7 to 5.4 p.p.m. on a

Table 1.—Summary of DDT analyses on treated vines.

Treatment	Time between Treatment and Sampling	Analyses	Samples Containing DDT	DDT (dry weight)	
				Average	Maximum
	Days	*Number*	*Number*	*P.p.m.*	*P.p.m.*
Dust	2–3	2	2	9.0	13.6
	22–23	3	2	8.1	8.6
Spray	17–23	2	1	2.2	2.2
Freon aerosol[1]	17–20	3	3	31.5	51.2
	24–27	3	1	1.0	1.0
Methyl chloride aerosol[1]	17	1	1	31.4	31.4
	23	1	0	0	0

[1] Applied at atmospheric temperatures ranging from 46°–50° F.

green-weight basis and 7.7 to 18.7 p.p.m. on a dry-weight basis, the daily intake for each cow being approximately 44 to 88 mg. of DDT. Chemical analyses of the milk by a colorimetric method (Schechter *et al.* 1947) were made on August 29, before feeding started, and once a week thereafter during the feeding period of August 30 to October 22, 1946. Samples of milk from the remainder of the university herd, which received no silage, were used as controls. The samples were taken by

toxicity to the flies in the cream from test cows. Tremors were observed, and the average mortality in six weekly tests was 25 per cent from one of the cows and 22 per cent from the other, as compared with only 7 per cent in the control. However, it is known from chemical analysis that much less than 50 p.p.m. of DDT was present in the milk of the test cows. In view of this fact and the observation made during these tests that flies are adversely affected by a cream diet, it appears inadvisable to use this insect for the biological detection of DDT in milk or to draw conclusions from data so obtained.

Table 2.—DDT residues on pea vine ensilage.

Treatment	Date Sampled	Analyses	Samples Containing DDT	Average Residue in Samples		
				Calculated on green weight from chlorine determination[1]	Calculated on dry weight	
					From chlorine determination	From colorimetric determination
	1946	*Number*	*Number*	*P.p.m.*	*P.p.m.*	*P.p.m.*
Dust	June 28	1	0	0.0	0.0	0.0
Spray	June 28	2	1	0.2	0.5	
	Aug. 7	2	2	6.6	16.5	9.9
Aerosol	June 28	1	1	0.1	0.2	0.0
	Aug. 7	3	3	7.3	17.4	12.4
	29	1	1	3.0[2]	7.7	
	Sept. 4	1	1	2.7[2]	8.0	
	Oct. 22	1	1	2.8[2]	9.5	
	23	1	1	4.3[2]	12.0	
	1947					
	Jan. 16	3	3	5.4	18.7	
	Oct. 21	3	3	2.8[2]	8.2	

[1] Computed on basis that dry weight was 40 per cent of green weight.
[2] Based on actual green and dry weight of sample.

combining milk from morning and evening milkings.

Weekly samples of milk from the cows receiving silage containing DDT showed traces of DDT, but the amount was less than 0.5 p.p.m., which is near the lower limit of the determination by the method used. The milk samples from control cows gave no evidence of DDT by either method of analyses.

In the tests with house flies, cream from the milk of the two cows was homogenized to reduce the size of the fat particles, since normal cream resulted in some mortality apparently because the flies were unable to digest it. For comparison synthetic creams were made up from skim milk and butter with DDT added at known concentrations, and likewise homogenized.

With the synthetic creams DDT concentrations of 50 p.p.m. or less could not be definitely detected on the basis of fly mortalities. There was evidence of some

SUMMARY.—In 1946 chemical analyses were made to determine the DDT content of red vines and silage from fields treated with DDT sprays, dust, and aerosols. The DDT content in milk from cows fed silage from pea vines that had been treated with Freon-propelled aerosols at the rate of 0.5 pound of DDT per acre was also analyzed.

Fifteen samples of the treated pea vines were taken from the field before harvest, analyzed, and found to contain this compound in amounts ranging from 0 to 51 p.p.m. on a dry-weight basis. Aerosols applied at low temperatures left larger amounts of residue than those applied at higher temperatures.

Silage made from some of the pea vines was found to contain DDT in amounts ranging from 0 to 18.7 p.p.m. on a dry-weight basis.

Silage made from pea vines that had been treated with Freon-propelled aerosols containing enough DDT to control the pea aphid (7.7 to 18.7 p.p.m.) was fed to two milk cows in their daily ration for a two-month period. Chemical analyses of the milk from these cows showed traces of DDT, but less than 0.5 p.p.m., which is near the lower limit of the determination by the colorimetric method.

The house fly did not seem to be a satisfactory test insect for detecting small amounts of DDT in milk.

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EIGHTH ANNUAL NORTHWEST VEGETABLE INSECT CONTROL CONFERENCE

The eighth annual meeting of the Northwest Vegetable Insect Control Conference was held in the Multnomah Hotel in Portland, Oregon on January 24, 25 and 26, 1949. This is a conference of State and Federal entomologists engaged in research or extension work on insects affecting vegetables in Idaho, Oregon, Montana, Utah, Washington and British Columbia. California also sent representatives this year.

The forenoon and part of the afternoon of the first day were devoted to workshop sessions. Insects affecting the following groups of vegetables were discussed: pea insects (T. A. Brindley, leader), potato insects (B. J. Landis, leader), soil insects (H. E. Morrison, leader), cole crops, lettuce, onions and corn (H. C. Manis, leader), sugar beets, table beets, tomatoes, beans and hops (W. E. Peay, leader), cane fruits, strawberries, currants, gooseberries, cranberries and blue berries (E. P. Breakey, leader). Later in the afternoon of the first day, R. L. Webster, Chairman, Division of Entomology State College of Washington presented a paper entitled: "New Insecticides: Their use, limitations and Hazard to Human Health." Following this paper, E. P. Breakey, Research Entomologist, Western Washington Experiment Station, Puyallup, Washington and Robert Every, Extension Entomologist, Oregon State College, presented talks on "The Relationships Between Extension and Research Entomologists."

During the forenoon of the second day the discussion leaders presented the reports of their respective groups to the membership of the closed session. In the afternoon of the second day and the forenoon, of the third day the discussion leaders presented their reports to representatives of the insecticide and vegetable crop industries.

On the evening of the second day members of the Vegetable Insect Conference and representatives of industry attended an entomologists dinner. Don C. Mote, Chairman Division of Entomology, Oregon State College, acted as chairman and representatives of industry presented short talks on new insecticides.

Recommendations were made at the conference for the control of pea aphis and pea weevil. There was also considerable interest in the results obtained with DDD in the control of the orange tortrix, a serious pest of cane fruits.

The executive committee in charge of arrangements for the 1949 conference was: George F. Knowlton, Utah State Agricultural College, Logan Utah, chairman; William C. Cook, U. S. Department of Agriculture, Walla Walla, Washington, co-chairmen and David H. Brannon, State College of Washington, Pullman, Washington, secretary-treasurer.

The following executive committee was elected for the coming year: T. A. Brindley, U. S. Department of Entomology, Moscow, Idaho, chairman, Robert W. Every, Oregon State College, Extension Service, Oregon, co-chairman; and David H. Brannon, State College of Washington, Extension Service, Pullman, Washington, Secretary-Treasurer.

DAVID H. BRANNON
Secretary-Treasurer

Toxicity of Residues from Carbon Dioxide-Propelled Insecticides

R. A. Fulton, O. C. McBride, and W. N. Sullivan, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*

The recent increase in airplane travel to and from foreign countries has intensified the problem of preventing the hitchhiking of insects. Preventive measures now in effect include quarantine inspection and the use of aerosols. The Bureau of Entomology and Plant Quarantine has studied the problem of freeing aircraft of insects by the use of space aerosols, residual sprays, and a combination of the two. This paper reports studies on the development of effective residual treatments for the interior of aircraft. Investigations were made on the longevity of effective residues and on the effect of repeated applications of insecticides on various surfaces, such as masonite, aluminum, cabin linings, and interior of aircraft.

Table 1.—Percentage composition of 10 formations tested as residual sprays in carbon dioxide-propelled solution.

Formula No.	DDT	Chlordan	Benzene Hexachloride	Piperonyl Butoxide	Methylated Naphthalenes[1]	Pyrethrum Extract	Acetone	Cyclohexanone	Deodorized Kerosene	Lubricating Oil	Dichlorodifluoromethane[3]	Methylene Chloride
G-485	10	—	—	—	10	—	—	—	—	—	20	60
G-486	10	—	—	—	5	—	—	—	—	—	20	65
G-496	10	—	—	—	10	—	65	10	—	—	5	—
G-542	10	—	—	—	—	—	—	—	5	—	20	65
G-543	5	—	5	—	10	—	—	—	—	—	20	60
G-545	10	—	—	—	—	—	—	—	2	3	20	65
G-554	10	—	—	5	—	—	—	—	—	—	20	65
G-556	5	4	—	5	—	—	—	—	—	—	20	66
G-560	10	—	—	5	—	5	—	—	—	—	20	60
ID-11390	90[2]	—	—	—	—	—	—	—	—	—	—	—

[1] Chiefly di- and trimethyl naphthalenes. (*Velsicol AR-60*)
[2] Water-dispersible powder applied as a 10 per cent spray.
[3] *Freon 12.*

The insecticides tested were DDT, pyrethrum, benzene hexachloride, piperonyl butoxide, and chlordan. They were applied as carbon dioxide-propelled solutions (Fulton 1948), a method that has been used during the past season for applying DDT in baggage compartments of aircraft. This method has several advantages. The solution is self-propelled, the fire hazard is reduced, undesirable carriers such as oils are not needed, and uniform coverage is obtained with no streaking of the surface being treated. Heavy dosages were used because they are necessary for effective kill of agricultural pests.

Experimental Methods.—The carbon dioxide-propelled solutions were prepared in the manner described for the dichlorodifluoromethane types (Goodhue & Sullivan 1942, Fulton *et al.* 1947). The insecticides were first dissolved in a suitable solvent and then placed in a pressure cylinder which had been previously evacuated. A low percentage of the propellant was added to the solution to prevent a decrease in pressure when the container was nearly empty. The cylinders were then charged with carbon dioxide by connecting them with a supply tank equipped with a reducing valve and gage. The valve was set for 180 pounds per square inch gage and the container was held in an inverted position so that the gas could bubble through the solution. When no more gas entered the cylinder, it was placed in tap water to cool the contents. This cooling caused a drop in pressure to near 140 pounds. The valve was then reset for 150 pounds, and the contents were shaken until no deflection was noticed in the carbon dioxide gage.

The solution was applied through oil-burner tips. The tip most suitable for this purpose is the 2.5-gallon-per-hour, 80° angle unit, which will discharge approximately 2.3 grams of the solution per second. If the tip is held approximately 16 inches from the surface and moved in a parallel plane at the rate of 1 foot per second, it will deposit about 75 mg. of insecticide per square foot.

The spray residues were applied on 9 by 9 inch panels of masonite and aluminum

suspended from a wall. The panels were removed from the wall periodically for testing. By this procedure all panels were exposed to the same conditions for the duration of the test. Second, third, and fourth treatments were made to a group of panels from the original series to determine the effect of repeated applications and heavier deposits.

The test insects for the work during the winter months included the American cockroach, *Periplaneta americana* (L.), the confused flour beetle *Tribolium confusum* Duv., and larvae of the black carpet beetle *Attagenus piceus* Oliv. For the late spring and summer tests, grasshoppers, the Mexican bean beetle, *Epilachna varivestis* Muls., the Japanese beetle, *Popillia japonica* Newm., the Colorado potato beetle, *Leptinotarsa decemlineata* (Say), *Tribolium* sp., the margined blister beetle, *Epicauta solani* Werner, and the American dog tick *Dermacenter variabilis* (Say) were used. From 50 to 100 insects were used in each test.

The insects were exposed to the insecticide residues for 1 hour by confining them on the panels by means of petri dishes. They were then transferred to clean holding cages which had been supplied with food and water, and mortality counts were made at 24-hour intervals for 4 days.

Table 2.—Mean per cent kill of confused flour beetles (adults) and American cockroaches (adults and nymphs) exposed to residues of formulations given in table 1, applied at the rate of 75 mg. per square foot.

Age of Residue (days)	G-485	G-486	G-496	G-542	G-543	G-545	G-554	G-556	G-560	ID-11390
					Aluminum panels					
1 application										
3	100	29	42	62	98	88	77	70	86	100
10	50	36	25	10	42	18	37	20	64	100
20	20	20	12	15	24	8	21	44	93	60
30	20	4	8	16	4	20	40	84	26	85
2 applications										
3	20	61	86	52	79	20	40	32	96	97
10	23	22	70	42	28	20	40	76	80	93
20	41	8	83	44	52	29	41	36	90	70
30	29	29	43	44	16	24	16	86	52	50
4 applications										
3	92	60	65	86	100	23	81	78	80	80
30	70	64	70	58	64	38	90	89	75	88
60	78	69	54	81	70	60	53	96	32	82
90	63	77	84	57	79	59	20	32	33	97
120	53	76	90	83	73	60	8	21	20	87
150	71	52	70	43	70	63	7	0	70	100
					Masonite panels					
1 application										
3	67	25	64	47	69	35	11	32	32	95
16	61	14	73		13	14	16	17	56	97
20	44	43	67	16	23	14	16	14	53	85
30	8	20	28	16	55	28	24	27	17	88
2 applications										
3	79	65	75	30	7	36	28	12	77	100
10	23	88	76	47	41	38	8	32	85	100
20	18	33	60	33	4	29	33	4	65	56
30	12	33	12	42	32	8	24	60	26	72
4 applications										
3	85	84	81	84	94	75	82	100	96	76
30	69	80	73	76	87	80	52	69	67	96
60	90	70	62	67	82	80	57		47	80
90	93	70	76	86	62	85	23	33	75	97
120	94	73	92	96	75	85	13	44	38	86
150	77	80	62	79	65	41	34	25	73	80

Insects showing any movement of legs or antennae at the end of the test period were considered alive.

Ten formulations were tested. Their chemical composition is shown in table 1. They were formulated to give the maximum deposit of insecticide.

The studies were divided into three series, as follows:

(1) One application of 75 mg. per square foot, with toxicity tests at 10-day intervals for 30 days.

(2) Two applications of 75 mg. per square foot 3 days apart, with four toxicity tests at 10-day intervals.

(3) Four applications of 75 mg. per square foot at 10-day intervals, with toxicity tests made after each application and continued for 150 days after the last application.

RESULTS.—Chemical analyses of the deposits on aluminum panels were made for each series and found to be approximately 75 mg. of DDT for each application.

In no case was there an appreciable loss from the panels held at room temperature. However, in later studies not reported in this paper, a loss was noted when the interior of a C-47 Army transport plane was treated with residual formula *No. G-560*. No decomposition of the DDT was detected in the plane, but temperatures as high as 180° F. were recorded inside the skin of the aircraft, where the material had been applied. Parts of the aircraft not directly exposed to the sun did not show this accelerated loss.

The kill of confused flour beetles and American cockroaches given by the 10 formulations is shown in table 2.

Most of the formulations at the 75-mg. dosage gave good kill on the third day. As the residue aged, however, the toxicity decreased. After 30 days the effectiveness of eight formulations had decreased 50 to 80 per cent. Dosages of 150 mg. gave kills about equal to 75-mg. dosages on the third day, but a smaller decrease in kill over a 30-day period. A dosage of 300 mg. per square foot gave kills about the same as the 150-mg. dosage. On the panels receiving 300 mg. per square foot toxicity tests were made at 30-day intervals for 150 days after the last application. For most formulations there was little or no decrease in kill over the 150-day period.

The four best formulations were retested against grasshoppers, roaches, and flour beetles. The results are shown in table 3. *G-560* was found to be the most effective on aluminum panels, followed in order by *G-556*, *G-496*, and *G-485*. This is the same general order that was found in the earlier tests.

Table 3.—Mean per cent kill of grasshoppers, roaches, and flour beetles exposed for 1 hour to residues of four carbon-dioxide propelled insecticide formulations.

NUMBER OF APPLICATIONS	G-485	G-496	G-556	G-560
		Aluminum panels		
1	75	76	55	82
2	49	52	83	100
3	61	84	100	97
4	61	44	82	86
5	69	90	82	86
6	67	73	74	90
7	—	—	—	—
8	34	86	100	100
[1]	73	65	92	97
[2]	27	60	94	79
[3]	60	65	72	85
		Masonite panels		
1	58	63	51	24
2	76	66	77	48
3	81	97	56	92
4	76	53	70	49
5	54	85	81	82
6	79	66	74	82
7	—	—	—	—
8	92	71	86	68
[1]	55	79	89	81
[2]	87	58	36	45
[3]	79	74	40	26

[1] 30 days after eighth application.
[2] 60 days after eighth application.
[3] 90 days after eighth application.

The effectiveness of *G-560*, a DDT formulation, against various insects is presented in table 4. On aluminum panels this formula was effective against grasshoppers, the Mexican bean beetle, the Japanese beetle, the Colorado potato beetle, blister beetles, and the American cockroach. On masonite, which is a more porous material with an irregular surface, it was not so effective.

The formulations containing DDT showed more visible deposit on aluminum than on masonite. When scratches or fingerprints were made on the aluminum surfaces before or immediately after they were treated, a crystalline growth formed along the scratch or ridge of the fingerprint. A 90 per cent DDT water-dispersible powder, applied as a 10-per cent spray was effective, but the white, blotchy appearance, especially on dark surfaces, would present a problem on airplanes.

SUMMARY.—The results of toxicity and chemical tests are given on a new method

Table 4.—Per cent kill in 96 hours of agricultural insects exposed for 1 hour to the residue of formulation G-560.

Number of Applications	Grasshoppers (Adult and Nymph)	Mexican Bean Beetle (Adult and Larvae)	Japanese Beetle (Adult)	Colorado Potato Beetle (Adult and Larvae)	Margined Blister Beetle (Adult)	Eastern Tent Caterpillar (Larvae)	Confused Flour Beetle (Adult)	American Cockroach (Adult and Nymph)	Black Carpet Beetle (Adult)	American Dog Tick
				Aluminum panels						
1	100	—	—	—	—	83	95	58	0	—
2	100	—	—	100	—	100	100	100	0	100
3	100	—	—	—	—	—	96	100	0	100
4	100	—	—	—	—	—	80	100	0	100
5	100	80	—	100	—	—	79	100	20	—
6	100	100	—	86	—	—	87	100	0	—
7	—	—	—	—	—	—	—	—	—	—
8	100	100	—	100	—	—	100	100	0	—
[1]	100	100	100	—	100	—	90	100	—	—
[2]	100	100	100	100	100	—	64	100	—	—
[3]	100	100	—	—	—	—	77	100	0	—
				Masonite panels						
1	—	—	—	—	—	0	33	8	0	—
2	—	50	—	—	—	50	62	25	0	—
3	66	—	—	—	—	—	91	100	0	—
4	100	—	—	—	—	—	36	100	0	—
5	66	100	—	100	—	—	100	56	0	—
6	50	100	—	80	—	—	79	100	0	—
7	—	—	—	—	—	—	—	—	—	—
8	100	100	—	100	—	—	53	100	—	—
[1]	100	17	100	90	100	—	64	100	—	—
[2]	17	100	100	—	—	—	31	33	—	—
[3]	80	0	—	—	—	—	26	17	0	—

[1] 30 days after eighth application.
[2] 60 days after eighth application.
[3] 90 days after eighth application.

for applying residual insecticides from carbon dioxide-propelled solutions in the treatment of aircraft interiors to kill hitchhiking insects. Residues applied in this manner gave a uniform deposit that were not unsightly, and there was no appreciable mechanical loss.

Cockroaches, flour beetles, and carpet beetles were used as the test insects in the winter months and various agricultural pests in the late spring and summer.

Deposits of 75 mg. per square foot were effective after 3 days but lost 50 to 80 per cent of their toxicity over a 30-day period. Deposits of 150 mg. gave the same kill in 3 days and lost effectiveness at a slower rate. At 300 mg. the initial kills did not increase, but most of the effectiveness was retained for 150 days after the last application. From the standpoint of toxicity to agricultural insects and suitability for treatment of the interiors of passenger-carrying aircraft, the formulation containing DDT, pyrethrum, and piperonyl butoxide was the most satisfactory.

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Insecticidal Properties of Some New Chlorinated Organic Compounds

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Ever since the insecticidal properties of DDT were recognized and reported, a wide variety of chlorinated compounds have been proposed as substitutes for or improvements on that compound, with the result that references to new chlorinated hydrocarbon insecticides abound in recent entomological literature. Unfortunately the various authors' conception of the term "new" is not constant, so that one cannot always tell from a study of titles whether the "new" insecticide is one previously unreported or whether it is merely more recent than DDT.

This paper is a summary of preliminary data on the physical and insecticidal properties of three chlorinated organic compounds, only one of which, to the authors' knowledge, has previously been recorded in the literature. For purposes of comparisons, data on DDT, benzene hexachloride, chlordan, and some other insecticides have been included in most of the discussions.

March & Kearns (1948) isolated, by the process of chromatographic absorption, a number of pure compounds from the mixture known as technical chlordan. The most active of these insecticidally was 1 (or 3a), 4,5,6,7,8,8-heptachloro-4:7-methano-3a,4,7,7a-tetrahydroindene (hereafter referred to in this paper as "I"). This compound is an almost odorless white or yellowish-white, crystalline solid, melting at 92–93° C. It is insoluble in water but is fairly soluble in most organic solvents, including refined kerosenes. In the presence of strong alkalies and probably also when exposed to certain metallic halides, it slowly decomposes with the liberation of hydrochloric acid.

A second chlorinated hydrocarbon, 1,2,3,4,10,10-hexachloro-1:4,5:8-diendomethano-1,4,4a,5,8,8a-hexa-hydronaphthalene (hereafter referred to as II), has been developed more recently than "I." This nearly odorless compound is a white, crystalline solid, with a melting point of 100–103° C. It is very highly soluble in most organic solvents, but is insoluble in water. It is stable in the presense of organic and inorganic alkalies and metallic chlorides, even when these materials are in solution with "II."

The third compound (III) is an oxygenated derivative of "II." It resembles "II" in most of its physical properties, although it is somewhat less soluble than "II" in organic solvents. Its melting point is 173° C. It is stable to strong alkalies but decomposes in the presence of strong acids. Inasmuch as "III" has only recently become available for tests and has not been prepared in quantities sufficient for field experiments, not all of the sets of data presented here include results on this compound.

The DDT (2,2-bis (p-chlorophenyl)-1,1,1-trichloroethane) used in these tests was aerosol grade or chemically pure (melting point 103° C. or above); the chlordan was the technical product (a mixture containing 60–75 per cent of 1,2,4,5,6,7,8,8-octachloro-4:7-methano-3a,4,7,7a-tetrahydroindane and 25–40 per cent of related compounds). Benzene hexachloride was used as the pure gamma isomer or as a product containing 40 per cent of the gamma isomer, but all results with this compound are reported in terms of gamma isomer. Technical grades of parathion (diethyl p-nitrophenyl thiophosphate) and chlorinated camphene (67–69 per cent chlorine) and commercial samples of 3,5-dinitro-o-cresol dusts were included in some experiments.

HOUSEFLY TESTS.—The initial tests with these new compounds were made on houseflies, using the windtunnel method of Roan & Kearns (1948). The results of these tests appear in table 1 as averages of five replicates of approximately 100 flies each. The LD-50 values by topical application of five compounds dissolved in 95 per cent ethanol solution, are given in table 2 as the micrograms of toxicant per gram of fly weight. The treatments were made to the thorax of flies, lightly anesthetized by CO^2, in a manner similar to that proposed by Trevan (1922). The relative length of residual effectiveness

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Table 1.—Average per cent mortality of houseflies sprayed by wind-tunnel technique. Each figure based on results from five replications of approximately 100 flies each.

Conc. mg./ml.	Average Per Cent Mortality, 24 Hours					
	DDT	Chlordan	γ Benzene hexachloride	"I"	"II"	"III"
2.0	98	100				
1.0	92	96				
0.5	60	73				
0.25	23	37	97	98	93	100
0.125	12	17	86	86	82	96
0.06			47	53	58	77
0.035			31	28	26	54
0.0175			20	14	17	31

Deobase control=3.4 per cent mortality

was determined by exposing three groups of approximately 125 flies each for 30 minutes to 50 mg./square foot residues of the compounds applied to glass plates in acetone solution. The average 24-hour mortality of the groups of flies is recorded in Table 3.

Table 2.—LD-50 values on houseflies, based on topical application of some chlorinated compounds dissolved in 95 per cent ethyl alcohol. Values expressed as micrograms of toxicant per gram of fly weight.[1]

Compound	LD-50 in Micrograms
DDT	20.5
Chlordan	4.0
γ isomer	2.9
"I"	1.7
"II"	1.6
"III"	1.1

[1] Data from results of tests made by W. W. Bruce, Assistant Entomologist, Illinois Natural History Survey.

The data in tables 1 and 2 indicate that "I," "II," and "III" are of about the same order of toxicity as benzene gamma hexachloride being roughly 8 to 18 times as toxic as DDT to houseflies. The length of residual effectiveness (Table 3) of "I" and "II" is about like that of chlordan, but "III" has a much longer residual effect, showing only a very slight decrease in effectiveness after a month.

An indication of the rapidity of action of the materials listed in table 1 was afforded by tests in which groups of flies were exposed for only 10 minutes to fresh deposits of these compounds applied to glass at the rate of 1 milligram per 1000 sq. cm. Observations were made at 30 minute intervals for 5 hours after the insects were removed from the treated surfaces. The relative speed of action, from fastest to slowest, was gamma benzene hexachloride > II = III > I > chlordan > > DDT. Flies exposed to gamma isomer were 100 per cent paralyzed in 2 hours. All of the other compounds produced 100 per cent paralyzed in from 3.5 to 5 hours.

Roach Tests.—Tests by topical application of five chlorinated, organic compounds dissolved in dioxane were made on adult American cockroaches *Periplaneta americana*, and adult male German cockroaches, *Blatella germanica*, and tests of residual surfaces of the same five com-

Table 3.—Per cent mortality of houseflies 24 hours after a 30-minute exposure to a deposit of 50 mg. per sq. ft. of some chlorinated insecticides at various intervals after application. Each figure based on three replicates of 125 flies each. Compounds deposited on glass plates.[1]

Compound	Age of Residues in Days					
	5 Days	14 Days	21 Days	28 Days	35 Days	51 Days
DDT	73.7	41.1	19.1	11.5		4.3
Chlordan	93.4	58.9	1.8			
Parathion	4.0	11.1	1.6			
"I"	100.0	27.0	2.0			
"II"	83.8	30.0	17.9	4.6		
"III"	100.0	100.0		95.7	71.1	64.3
Control	0.6	4.0	1.0	1.7		2.3

[1] Data from results of tests made by W. N. Bruce, assistant entomologist, Illinois Natural History Survey and G. F. Ludvik, special research assistant, Illinois Natural History Survey and Illinois Agricultural Experiment Station.

pounds were run against adult *B. germanica* males. Topical applications were made by applying predetermined dosages of the experimental materials dissolved in dioxane to the abdominal sterna. The concentration was adjusted so that one cubic millimeter of solution was applied to each roach (Trevan 1922).

dan. It is apparent from data in table 4 that the gamma isomer has the greatest speed of action. At all concentrations, this insecticide produced the maximum mortality in 24 hours, whereas the other treatments show a progressive increase in mortality from 1 to 5 days. Compound "III" exhibits the longest residual effec-

Table 4.—Toxicity of some chlorinated insecticides to adult American roaches by topical application. Toxicants applied in dioxane solutions at rate of 1 cubic millimeter per individual.

Compound	Dosage γ/g. Roach	Per Cent Paralyzed Adult Roaches Hours After Treatment				
		24	48	72	96	120
Chlordan	50.0	90	100			
	35.0	70	80	100		
	25.0	20	60	60	60	80
	15.0	0	0	20	50	70
	10.0	0	0	10	60	70
γ Benzene Hexachloride	20.0	80	90	100		
	15.0	80	90	90	90	90
	10.0	90	80	80	80	80
	5.0	60	60	60	60	60
	2.5	70	70	70	70	70
	1.25	40	40	40	40	40
I	25.0	100				
	12.5	90	100			
	10.0	80	90	100		
	7.5	80	90	100		
	5.0	0	50	70	100	
	2.5	0	20	70	80	100
	1.25	0	0	20	50	60
II	25.0	90	100			
	12.0	40	80	100		
	12.5	90	100			
	10.0	80	90	100		
	7.5	30	90	100		
	5.0	30	50	100		
	2.5	20	70	70	80	80
	1.25	0	20	40	40	60
III	10.0	90	100			
	5.0	25	75	100		
	4.0	40	56	72	84	100
	2.0	0	28	80	88	88
	1.0	0	0	10	15	15
Dioxane	Control	0	0	0	0	0

Table 4 is a summary of results on American roaches, and the data on German roach tests appear in tables 5 and 6. DDT was not included in these series of experiments since previous experiense had demonstrated that the toxicity of DDT to roaches is far below the dosage range at which these five compounds were applied. Against both species of roaches, compound "III" gave slightly better results than "I," "II," or γ-benzene hexachloride and was more toxic than chlor-

tiveness (Table 6), producing a 90-per cent kill of adult German males exposed for 48 hours to a 49-day-old residue of only 1 mg. per 1000 sq. cm. None of the other compounds gave an appreciable kill at this low level of deposit even 21 days after treatments were made.

TESTS ON GRASSHOPPERS.—The LD-50 values for adult *Melanoplus differentialis* (Weinman & Decker)[1] show that "I,"

[1]See article on page 135.

Table 5.—Toxicity of some chlorinated insecticides to adult male German roaches by topical application. Toxicants applied in dioxane solutions at 1 cubic millimeter per roach.

Dosage γ/g. Roach[1]	Average Per Cent Mortality 72 Hours After Treatment				
	Chlordan	BHC	I	II	III
20.0	92				
16.0	86				
10.0	50				
7.0	28				
5.0	8	82	100	98	100
4.0		61	99	96	100
3.5		43	87	80	98
2.8		38	58	60	90
2.4		18	41	28	72
1.6		12	27	4	40
1.4		4	8		11

[1] Based upon an average weight of 50 mg. for an adult male roach.

"II," and "III" are approximately six times as toxic as chlordan as contact insecticides and are three to four times as toxic as chlordan as stomach poisons. Parathion was more toxic than the three new chlorinated compounds in contact effect but was less toxic as a stomach poison γ-Benzene hexachloride was intermediate in toxicity between "I," "II," "III," and parathion, by both methods of test.

Tests on Milkweed Bugs.—The LD-50 values for five chlorinated insecticides obtained by topical application of various concentrations of the compounds in 1 cubic millimeter of dioxane on the scutellum of adult females of the large milkweed bug, *Oncopeltis fasciatus*, are given in table 7. In this instance, "II" appears to be 50 per cent more toxic than "III," three times as toxic as I and the gamma isomer, and approximately 12 times more toxic than chlordan.

Table 7.—LD-50 values by topical application on adult female milkweed bugs 96 hours after treatment.

Compound	LD-50 in Micrograms Per gr. of Bug[1]
Chlordan	144.8±2.5
γ BHC	32.5±2.5
I	31.3±1.3
II	10.3±7.5
III	15.0±5.0

[1] Based on an average weight of 80 micrograms per bug.

Chinch Bug Experiments.—Eight organic insecticides, formulated as dusts of various concentrations were tested on chinch bugs, *Blissus leucopterus*, using the technique reported by Decker (1943). Tests were run in replicates of 10 bugs each over a period of several days. The test insects were adults collected from their hibernating quarters in November. Results of this series of experiments are summarized in table 8.

The minimum effective concentration for 3,5-dinitro-o-cresol, which has become the standard toxicant for chinch-bug dust barriers, appears to be 0.5 per cent by this method of testing. Concentrations of 1 to 8 per cent consistently gave 100 per cent mortality in 24 hours. Although none of these newer chemicals may possess the physical properties necessary for effective chinch-bug control by toxic-dust barrers, the results in table 8 indicate that gamma isomer, "II", and "III" as freshly prepared dusts, are equal or superior to dinitro-ortho-cresol in toxicity. None of the chlorinated materials, however, acts so fast as dinitro-ortho-cresol, the gamma isomer being the only one of the group which approaches it in this respect.

Tests on Full-Grown Larvae of the Codling Moth.—The data in table 9.

Table 6.—Residual toxicity of 1 mg./1000 square centimeters deposits of some chlorinated insecticides to adult male German roaches at various intervals after application. Percentage dead and moribund after exposure periods of 24 and 48 hours.

Compound	Age Deposits in Days											
	1		7		21		28		42		49	
	24	48	24	48	24	48	24	48	24	48	24	48
Chlordan	100	100	24	92	0	0	0	0				
γ BHC	100	100	14	18	0	0	0	0				
I	100	100	64	100	0	26	0	0				
II	100	100	22	100	0	0	0	0				
III	100	100	100	100	100	100	100	100	46	100	24	90

summarizing tests with seven organic insecticides applied topically to full-grown larvae of *Carpocapsa pomonella*, are of interest principally because they demonstrate the lack of toxicity of the chlorinated hydrocarbons to this stage of the codling moth. Only DDT at the exceedingly high dosage of 20 to 45 mg./gram and gamma isomer at a somewhat lower dosage range (2 to 13 mg./gram) gave kills appreciably above the mortality in the solvent checks. Parathion, however, gave complete kill at all dosages above 0.0185 mg./gram and produced mortality in excess of check results at all dosages above 0.0075 mg./gram. During the course of these experiments, it was obvious to the authors that the greater toxicity of parathion is related to its far greater speed of action: Larvae treated with parathion at effective concentrations showed the toxic effects of the insesticide almost immediately and rarely succeeded in spinning more than a few strands of a cocoon before death occurred. Those larvae treated with the chlorinated hydrocarbons, however, appeared normal as soon as the solvent had evaporated. Moreover, they proceeded to spin pupal cocoons, and the relatively few individuals which died as the result of the application of the chlorinated materials were in the pupal stage when death occurred. It seems logical to suspect that the greater speed of action and apparent toxicity of parathion is related to the ability of this compound to penetrate the body wall of mature codling-moth larvae and was not due to a fumigation effect.

Table 8.—Toxicity of dust formulations of some organic compounds applied to adult chinch bugs. Ten bugs used in each replicate.

Compound	Per Cent Conc.	Replicated	Per Cent Dead After 1 Day	2 Days	3 Days	4 Days
Dimtro-o-cresol	1.00	3	100			
	0.50	4	93	93	95	98
	0.25	4	28	60	63	63
	0.125	5	0	0	0	2
	0.10	5	12	18	20	26
DDT	5.00	5	0	12	40	48
	2.00	2	0	10	25	30
Toxaphene	10.00	3	0	66	100	
	5.00	5	4	36	80	100
	1.00	5	4	6	12	42
Chlordan	5.00	5	8	33	73	92
	2.00	4	18	80	88	100
	1.00	5	8	20	44	60
γ Benzene Hexachloride	1.00	5	92	98	100	
	0.50	5	62	84	94	100
	0.25	5	44	72	88	92
	0.125	5	40	72	88	98
	0.10	5	34	40	64	74
I	1.00	5	4	40	70	84
	0.50	5	2	40	60	82
	0.25	5	0	2	10	38
	0.125	5	0	8	26	43
	0.10	5	0	8	10	12
II	1.00	5	18	64	88	100
	0.50	5	19	47	79	96
	0.25	5	6	18	52	80
	0.125	5	0	22	56	86
	0.10	5	0	6	20	32
III	1.00	5	36	78	98	100
	0.50	5	27	61	93	100
	0.25	5	22	57	84	100
	0.125	5	8	28	66	87
	0.10	5	0	6	30	41
Pyrax	100.0	5	0	0	4	4
No Treatment		4	2	2	2	2

Table 9.—Average per cent mortality of mature codling-moth larvae treated with solutions of some organic insecticides by topical applications.

Compound	Dosage Range in Milligrams Toxicant per Gram Larval Weight	Number of Tests	Average Per Cent Mortality
DDT	0.1 –20.0	115	21.6
	20.0 –45.0	10	19.0
Chlorinated camphene	0.5 –20.0	108	7.5
	20.0 –61.0	15	13.3
Chlordan	0.1 –20.0	156	6.4
	20.0 –55.0	16	12.5
γ Benzene Hexachloride	0.004 – 2.0	72	18.0
	2.0 – 4.0	20	65.0
	4.0 –13.2	10	60.0
I	0.1 –10.0	168	7.7
	10.0 –41.0	25	16.0
II	0.5 –10.0	102	11.0
	10.0 –40.0	23	10.7
Parathion	0.0025– 0.0050	3	0.0
	0.0050– 0.0125	39	48.7
	0.0125– 0.0200	43	74.4
	0.0206– 0.3500	59	100.0
Solvent controls		152	11.2

BLACK CARPET BEETLES AND THE WEBBING CLOTHES MOTH.—The resistance of wool samples treated with various low concentrations of six chlorinated organic insecticides to attack by larvae of the black carpet beetle, *Attagenus piceus*, and the webbing clothes moth, *Tineola bisselliella*, was investigated according to the method described by Fletcher (1943), except that only mortality and visual damage were used as criteria of effectiveness. Ten larvae of each species were placed on duplicate treatments and held for 2 weeks, during which time frequent observations on damage to wool and on larval mortality were made. At the end of that period, live and moribund larvae were removed from

Table 10.—Extent of feeding (0=none; 10=holes in wool) and per cent mortality of black carpet beetle and webbing clothes moth larvae confined on wool circles treated with various percentage solutions of some chlorinated compounds in ethyl alcohol. Ten insects used in each infestation per test.

		Carpet Beetles				Clothes Moths			
		2 Weeks After 1st Infestation		1 Week After 2nd Infestation		2 Weeks After 1st Infestation		1 Week After 2nd Infestation	
Compound	Per Cent Conc.	Per Cent Dead & Moribund	Feeding	Per Cent Dead & Moribund	Feeding	Per Cent Dead & Moribund	Feeding	Per Cent Dead & Moribund	Feeding
DDT	0.1	40	0	80	0	90	0	40	0
	0.05	60	0	30	0	66.7	0	10	1
	0.025	20	0	0	0	70	2	70	3
	0.1	0	0	0	0	30	8	10	9
Chlordan	0.1	50	0	10	0	50	1	40	1
	0.05	60	3	20	3	16.7	1	20	3
	0.025	0	3	0	6	0	1	20	5
	0.01	0	5	0	7	0	4	30	4
γ Benzene hexachloride	0.1	100	0	0	1	100	0	80	1
	0.05	50	1	0	3	90	0	10	2
	0.025	0	2	0	5	50	0	10	5
	0.01	0	3	0	6	30	1	0	5
I	0.1	100	0	0	3	50	1	20	1
	0.05	100	0	0	2	40	1	0	2
	0.025	80	0	20	2	60	3	0	6
	0.01	20	1	20	3	40	3	0	6
II	0.1	100	0	30	1	90	0	100	0
	0.05	100	1	40	2	80	0	20	0
	0.025	100	1	0	3	80	1	20	1
	0.01	30	1	10	4	80	1	0	2
III	0.5	100	0	100	0	100	0	50	0
	0.1	100	0	100	0	100	0	80	0
	0.05	90	0	20	0	60	0	90	0
	0.025	100	0	100	1	60	0	50	0
	0.01	100	0	100	0	50	0	100	0
	0.005	100	0	100	0	60	1	20	1
Alcohol Check		10	5	0	8	30	7	0	8

the test circles, and damage to the fabric was assessed by examination under low magnification. An arbitrary scale of 0 to 10 (0=no feeding, 5=moderate damage, 10=holes in wool) was used to indicate the relative extent of feeding. All treatments were then reinfested immediately with 10 fresh larvae per test dish, and records were again made a week later. These results appear in table 10.

Against black carpet beetle larvae, DDT and "III" were the only compounds which prevented damage almost completely at all concentrations during the two periods of infestation. Compounds "I" and "II" were almost as effective during the first 2 weeks, but showed a marked reduction in toxicity and repellency after the tests were reinfested. Chlordan and γ-benzene hexachloride were relatively less effective than the other materials except at the 0.1 per cent level.

DDT was much less effective against clothes moths than against carpet beetles. Compound "II" gave some indication of the same tendency. Only "III" was almost completely effective at all concentrations against clothes moths after the second infestation.

Another test method, patterned after one developed by Warren Moore[1], was used to investigate the relative toxicity of six organic compounds to black carpet beetles. In this method the test compound is dissolved in a volatile solvent and in-

[1] Private communication, 1945.

timately mixed with suitable larval food (ground dog food, fishmeal and yeast, etc.) as the solvent evaporates. The treated food is then placed in a 50-mm. crystalizing dish, and a mated pair of young adult carpet beetles is introduced into the dish. Observations are made at two day intervals until death of the female occurs, after which less frequent observations are made, and the presence of eggs or hatched eggs and living or dead larvae is recorded. Table 2 presents results of this series of tests, expressed as the minimum effective concentration—*i.e.* the concentration at which and above which no eggs were laid or no larvae succeeded in living past the first instar.

DDT, an effective insecticide against carpet beetles, is shown by the data in table 2 to be only 0.25 per cent, or less, as toxic as the other compounds by this treated-food technique. Both gamma isomer and parathion are effective at remarkably low dosages. Here again, the relative speed of action plays an important part, since in most tests at effective levels of gamma isomer or parathion, the adults were quickly paralyzed even before the females had a chance to deposit eggs.

FIELD-LABORATORY TESTS ON ADULT PLUM CURCULIO.—Early in the spring, adult curculios, *Conotrachelus nenuphar*, were collected at intervals by jarring from apple and peach trees in the extreme southern section of Illinois. As soon as the leaves on peach trees at Urbana had opened fully, 4-year old trees were thoroughly sprayed with the several formulations of insecticides by means of a portable power sprayer. Leaf samples were taken soon after the leaves had dried and were brought into the laboratory for tests. Groups of leaves from each treatment were placed on cheesecloth stretched over a petri dish half full of distilled water. Ten curculio adults were placed on the leaves, and the leaves and insects were covered with a screened retainer made from the top of a pint, round, ice-cream carton. A wad of cotton soaked in distilled water was placed on each screen cover to provide free water for the insects. Without access to free water, the curculios died in 1 or 2 days, even in control tests. Fresh leaves were brought in daily during the 5 days of observation, and daily records were made on numbers of insects alive and dead and on extent of feeding. Similar tests were begun at intervals up to a week after the trees were sprayed, to check the duration of effectiveness of the residues on foliage. All tests were replicated five times. The re-

Table 11.—Concentration (in parts per million) of some organic insecticides impregnated in larval food necessary to prevent oviposition or development of black carpet beetle larvae beyond first instar.

COMPOUND	MINIMUM EFFECTIVE CONC., P.P.M.
DDT	400.0
Chlordan	10.0
γ Benzene Hexachloride	2.8
I	5.0
II	10.0
Parathion	2.5

Table 12.—Field-laboratory tests on adult plum curculios. Insecticide formulations sprayed on young peach trees in the field. Leaves from sprayed trees removed at intervals, brought into the laboratory, and infested with 10 curculios. Figures are averages of five replicates.

COMPOUND	DOSAGE IN LBS./100 GALS.	DAYS AFTER TREATMENT	PER CENT DEAD ON 5TH DAY
DDT Wettable Powder	2.00	0	79
		3	14
Chlorinated camphene (Emulsion)	2.00	0	69
		3	20
Chlordan Wettable Powder	1.00	0	92
		1	48
		3	17
		7	38
	0.50	0	70
		3	20
	0.25	0	30
		3	14
γ Benzene Hexachloride Wettable Powder	0.15	0	98
		1	36
		3	26
		7	19
I Emulsion	1.00	0	98
		3	40
		7	52
	0.50	0	94
		3	26
	0.25	0	82
		3	10
II Emulsion	1.00	0	100
		3	45
		7	55
	0.50	0	98
		3	32
		7	16
	0.25	0	60
		3	28
Parathion Wettable Powder	0.15	0	100
		3	27
		7	6
Check—No Treatment		0	20
		1	30
		3	4
		7	2

sults of tests on seven organic insecticides against plum curculio appear in table 12.

Although DDT and chlorinated camphene have been regarded as of little value in curculio control, the relatively high dosage of 2 lbs. to 100 gals. of these materials showed some initial toxicity. Leaves removed from the trees 3 days after application of these insecticides, however, produced a low percentage mortality. All of the other treatments showed a high toxicity at all dosages in tests on leaves removed the same day that the trees were sprayed, but only "I" and "II" produced an appreciable mortality after 3 days, and these only at the 1-lb. dosage. The initial toxicity of these two materials at the 0.5 and 0.25 lbs. to 100 gals. dosages was substantially higher than that of chlordan at similar concentrations.

TESTS ON TWO-SPOTTED MITES.—The lack of toxicity of DDT and γ-benzene hexachloride to phytophagous mites has brought about a serious problem of controlling these pests on crops sprayed or dusted with either of these insecticides for the control of primary pests. The authors have conducted preliminary experiments on the direct effect of spray applications of DDT, gamma isomer, chlordan, "I", "II," and "III" to two-spotted spider mites, *Tetranychus bimaculatus*, infesting greenhouse roses.

DDT, γ-benzene hexachloride, and "II," sprayed in acetone-water wetting agent solutions at 1 to 500 on excised rose leaves, produced a mortality of mobile stages of approximately 20 per cent, but these compounds had no apparent effect on eggs or resting stages. Chlordan and "I," similarly applied, produced an initial kill of 30 to 50 per cent but seemed to be residually toxic, especially to hatching larvae and newly emerged resting stages. Compound "III" showed no mortality of mobile stages over the checks 24 hours after spraying, but many of the mobile stages and most of the newly emerged resting stages were visibly affected. Mortality records (mobile stages) for "III" 3 days after spraying were 100 per cent at 1 to 500 and 85 per cent at 1 to 1000. Moreover, scarcely any live larvae or resting stages could be found on the leaves 4 and 5 days after treatment.

It is probably true that none of the chlorinated compounds here discussed is a promising acaricide, since even compound "III" is slow in its action and, in these tests, was used at concentrations far greater than would be practical under most field conditions. It does seem logical to anticipate, however, that applications of "III" and possibly "I" may not lead to serious mite trouble.

SUMMARY.—The physical and insecticidal properties of three new chlorinated hydrocarbons, "I" (1(1)or 3a),4,5,6,7,8,8-heptachlor-4:7-methano-3a,4,7,7a-tetrahydroindene), "II" (1,2,3,4,10,10-hexachloro-1:4,5:8-diendomethano-1,4,4a,5,8,8a-hexahydronaphthalene), and "III" (an oxygenated derivative of "II") are presented and in part compared with similar properties for five other rather well known compounds.

While minor exceptions may be noted, rather extensive tests on 10 species of insects show the relative toxicity of the materials to be as follows: "III">"II" ="I"=gamma benzene hexachloride >chlordan>chlorinated camphene> DDT. The residual effectiveness of the materials seems to fall in the order: "III>">DDT>"II">"I" = chlordan >gamma benzene hexachloride.

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Chlorinated Hydrocarbon Insecticides Used Alone and in Combinations for Grasshopper Control

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During the summer of 1946 the relative effectiveness of DDT, benzene hexachloride, chlorinated camphene, and chlordan against grasshoppers was investigated by the authors (Weinman & Decker, 1947; Weinman *et al.* 1947). Commercial use of chlordan and chlorinated camphene in 1947 and especially during 1948, when approximately a half-million acres were sprayed or dusted in Illinois with these materials, has given convincing evidence that insecticidal sprays for grasshopper control are not only practical but give much more satisfactory results than are usually obtained from poison baits under Illinois conditions. Observations made during the past two seasons have strengthened the conviction that in Illinois, at least, successful control of all economic species of grasshoppers can be effected from the use of 0.5 lb. of chlordan or 1 to 1.5 lbs. of chlorinated. camphene per acre early in the season or by the application of 1 lb. of chlordan or 2.5 to 3 lbs. of chlorinated camphene per acre later, when grasshoppers are mature. These observations, moreover, have indicated again that sprays of these materials are superior to dusts, both in initial kill and in persistence of effectiveness.

Since 1946 several new compounds have become available for experimental work. Laboratory and small-plot field tests, similar to those carried out against grasshoppers in 1946, have been conducted on these materials to determine what place, if any, they may have in future control practices. In addition certain combinations of chlorinated hydrocarbon insecticides have been tested in order to discover what synergistic or antagonistic effects may be expected from the combined action of two related materials. The discussions which follow summarize results of investigations on the following materials: DDT (2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane), chlorinated camphene (67–69% chlorine), the gamma isomer of benzene hexachloride, chlordan (a mixture containing 60 to 75 per cent of 1,2,4,5,6,7,8,8-octachloro-4:7-methano-3a,4,7,7a-tetrahydroindane and 25–40 per cent of related compounds), a tetraethyl pyrophosphate, the so-called hexaethyl tetraphosphate, parathion (diethyl p-nitrophenyl thiophosphate), 1 (or 3a), 4,5,6,7,8,8-heptachloro-4:7-methano-3a,4,7,7a-tetrahydroindene (hereafter referred to as "I"), 1,2,3,4,10,10-hexachloro-1:4,5:8-diendomethano-1,4,4a,5,8,8a-hexahydronaphthalene ("II"), and an oxygenated derivative of "II" ("III"). The last three compounds are described and discussed by Kearns, *et al.* in this issue of the Journal.

SMALL-PLOT FIELD TESTS—All of the tests discussed in this section were run in 1948. Early in the season (June 14), when differential grasshoppers, *Melanoplus differentialis*, were predominately in the second instar, a series of 18 0.025-acre plots was set up in a 10-acre field of red clover near Lincoln, Illinois. Each plot was completely surrounded by untreated, check plots. Treatments were made by carefully weighing the amount of compound to be applied to 0.025 acre, dissolving the compound in a suitable solvent, adding emulsifier, and diluting with water to about 1 gallon in a 2.5 gallon, compressed-air sprayer. The sprayer was of such design that all but a few drops of the liquid in the tank could be forced out.

Counts were made in all the plots and check areas 1, 2, 4, 8, and 10 days after the spray was applied, by sweeping with a standard net. The results of these tests, given in table 1, are expressed as the percent reduction in grasshoppers in the treatments, based on the average infestation in the check plots on either side. Negative percentages, of course, indicate more grasshoppers in the treatment than in the adjacent check plots. Although there were variations in numbers of insects from plot to plot, the average infestation over the entire field was 40 to 50 per square yard.

Three weeks after the first series of tests was made, a second series was started in

[1] Entomologist, Illinois Natural History Survey.
[2] Entomologist and Head, Illinois Natural History Survey and Illinois Agricultural Experiment Station.

Table 1.—Per cent reduction in young grasshoppers in 0.025-acre treatments, based on counts made in two adjacent check areas.

Compound	Lbs. per Acre	Per Cent Reduction After				
		1 Day	2 Days	4 Days	8 Days	10 Days
Chlordan	1.00	88	100	74	82	42
Chlordan	0.50	69	80	76	41	39
Chlordan	0.25	75	37	48	0	0
Chlorinated Camphene	1.00	61	77	60	61	63
Chlorinated Camphene	0.50	0	86	78	20	−24
γ isomer	0.50	82	96	93	32	52
γ isomer	0.30	97	84	56	21	− 4
"I"	0.50	94	94	90	67	53
"I"	0.25	91	92	91	55	41
"I"	0.125	59	48	72	45	56
"I"	0.10	65	78	38	50	20
"I"	0.04	−42	32	16	− 4	−41
"II"	0.50	90	98	95	84	77
"II"	0.25	87	77	75	64	60
"II"	0.125	70	76	62	28	20
"II"	0.10	79	69	31	77	49
"II"	0.04	−26	5	43	−14	−50
Parathion (tech.)	0.15	100	79	70	26	36
Ave. counts, all check plots		23	40	73	69	43

another part of the same field. At this time differential nymphs were mostly in the third and forth instars. Eighteen 0.025-acre plots were set up in duplicate, again with check plots surrounding each treatment. The figures in table 2, summarizing the results of this second Lincoln experiment, are the average per cent reductions in numbers of grasshoppers in the duplicate treatments, based on sweeps made in two adjacent check plots for each replicate.

A third series of small-plot field tests was begun near LeRoy, Illinois, on July 24 in an 80-acre field of mixed alfalfa, red clover, and timothy. In this series three replicates of each of 20 formulations were tested in 0.25 acre (104 by 104 foot) plots. The test plots were adjacent, with chlordan borders at the ends of each group of replicates, so that each plot was bordered by a treatment on three sides and by an untreated area on the fourth side. The three replicates were placed in three

Table 2.—Average per cent reduction in young grasshoppers in duplicate 0.025-acre treatments, based on counts made in two adjacent check areas for each replicate.

Compound	Lbs. per Acre	Per Cent Reduction After		
		1 Day	2 Days	5 Days
Chlordan	1.00	89	64	80
Chlordan	0.50	83	75	69
Chlorinated camphene	2.00	89	76	69
Chlorinated camphene	1.00	86	33	40
γ isomer	0.30	70	48	48
γ isomer	0.15	44	45	54
"I"	0.50	86	70	83
"I"	0.25	72	76	76
"I"	0.10	79	67	56
"I"	0.05	54	26	60
"II"	0.50	73	49	83
"II"	9.25	76	73	83
"II"	0.10	65	56	60
"II"	0.05	55	28	29
Parathion (tech.)	0.25	80	69	43
Parathion (tech.)	0.125	68	67	52
Tetraethyl pyrophosphate	0.25	87	46	60
Hexaethyl tetraphosphate	1.00	68	41	47
Ave. counts, all check plots		55	73	94

widely separated locations in the 80-acre field. The average infestation in the field at the beginning of the experiment was 85 to 120 grasshoppers per square yard, mostly third, fourth, and fifth instars of *Melanoplus differentialis*, with some *M. femur-rubrum* nymphs and an occasional adult of *M. differentials* or *M. mexicanus*. Treatments were made with a small power sprayer equipped with a 13-foot boom. The delivery rate was adjusted to 5 gallons of total spray per plot. The results of the LeRoy experiment appear in table 3. All of the compounds and mixtures were formulated as emulsions, except as otherwise noted in the table.

Table 3.—Per cent reduction in large grasshopper nymphs in 0.25-acre treatments, based on counts made in adjacent check areas.

Compound	Lbs. per Acre	Per Cent Reduction After Days Indicated						
		1	2	3	5	5	7	12
Chlordan	1.00	80.7	80.7	85.8	67.3	84.4	94.6	81.8
Chlordan	0.50	91.5	78.0	88.5	76.7	73.1	76.7	75.0
Chlordan	0.25	94.8	59.9	76.4	61.0	86.4	76.8	69.1
Chlorinated camphene	2.00	52.5	68.5	56.7	82.4	95.9	89.3	92.7
DDT	2.00	42.1	39.1	6.3	54.1		−25.0	43.6
I	0.50	96.2	95.9	92.3	94.2		100.0	90.0
I	0.25	93.4	92.4	91.3	86.8		83.9	79.2
I	0.125	91.4	83.8	73.2	86.2		66.1	88.7
II	0.50	97.2	92.4	93.7	95.0	99.3	94.6	100.0
II	0.25	95.2	66.3	84.6	74.4	92.3	96.7	96.9
II	0.125	67.3	65.9	90.8	96.9	73.1	97.9	100.0
Chlordan Wet. po.	1.00	87.6	88.8	76.4	98.1		89.3	74.5
γ isomer Wet. po.	0.60	73.3	80.5	78.2	85.9		79.2	75.0
"II" Wettable powder	0.25	95.3	95.1	92.0	98.4		100.0	87.5
Parathion	0.30	97.5	85.1	82.1	89.5		80.0	59.1
Hexaethyl tetraphosphate	1.00	86.4	65.9	72.4	1.6	3.8	52.1	25.0
DDT: Chlordan 7:1	2.00	81.4	83.8	74.0	79.2	87.8	66.1	84.9
DDT: Chlordan 3:1	2.00	71.7	−13.0	60.3	65.1	61.5	50.0	78.1
DDT: "I"=15:1	2.00	84.7	70.7	66.4	75.0		93.8	75.0
DDT: "II"=15:1	2.00	97.2	93.4	93.7	95.0	98.6	98.2	100.0

Discussion of Small-Plot Tests.—Because of the tremendous pressure from the surrounding control plots in the two Lincoln experiments (Tables 1 and 2), none of the materials gave complete or nearly complete control of grasshoppers after 4 days. Reinvasion of the treated plots occurred in 24 to 48 hours in the benzene hexachloride and the 3 organic phosphate treatments, and only compound "II" at 0.5 lb. per acre showed any considerable control after 10 days in the first experiment. Materials "I"and "II" appear to be very similar in initial toxicity, but "II" has the longer residual effect.

Because the plots were much larger and were protected from reinvasion by adjacent treatments on three sides in the LeRoy tests (Table 3), most of the effective materials showed a longer period of residual activity. Again compound "II", even at the low dosage of 2 oz. per acre, was outstanding. At the lowest dosage (2 oz.), "I" was faster than "II" in its action, but it began to lose effectiveness after four days, even at the 4-ounce dosage.

Chlorinated camphene, at 2 lbs. per acre, was approximately as effective as chlordan at 1 lb. per acre but was slower in its action. Chlorinated camphene, both in the LeRoy and the Lincoln experiments, showed a somewhat longer residual action than chlordan at relatively high dosages. At LeRoy, where the test plot was fairly well protected from reinvasion, gamma isomer, used as a wettable powder at twice its recommended dosage, gave fair control throughout the test period, being approximately equal to parathion (at twice the dosage of parathion) and superior to hexaethyl tetraphosphate in this respect.

The combination of DDT and "II" in the ratio of 15 to 1 showed a quicker action than the comparable dosage (2 oz.) of "II" used alone, but the addition of DDT to "I" added little to the speed of action or to the ultimate control. There is a slight indication of synergism in the action

of DDT and chlordan in the ratio of 7:1 but the 3:1 combination indicates an actual antagonistic effect, since this mixture gave somewhat poorer results than the same dosage of chlordan 8 ounces used alone.

Because the "II" plot at Lincoln was the only one which showed a continued resistance to reinfestation during the entire period of observation, it seemed in order to check the possible repellent action of this compound. For this experiment, flats 14 by 20 inches were planted to corn and beans. When the plants were 6 to 8 inches high, half a flat was sprayed with "II" at a dosage of 4 lbs. to 100 gals., and the other half was left unsprayed. Other flats were similarly sprayed with "II" at 2 lbs. and 1 lb. per 100 gallons, with parathion at 1 lb., and with pyrax at 4 lbs. to 100 gals. One flat was left completely unsprayed. All of the flats were exposed to grasshopper attack in a field of red clover having a grasshopper population of approximately 25 per square yard. Bigger[1] has demonstrated that this half-flat method can be used to indicate even a weak repellency to grasshoppers. In these tests, however, none of the materials showed any degree of repellency, since the two halves of all the treated flats were eaten to about the same extent each day of the test, which was continued for 4 days.

In order to get more accurate data on the length of effectiveness of "II" residues strips of alfalfa were sprayed with this compound at dosages of 0.25 lb., 1 lb., and 5 lbs. per acre. Samples of the green-plants were brought into the greenhouse 1, 5, 10, 13, 17, and 22 days after the application of the insecticide. The samples were placed in bottles of water and under cages, and five *Melanoplus differentialis* adults were introduced into each cage. Tests at each dosage and control cages were replicated 5 times in each series. Each figure in table 4, which summarizes this experiment, is therefore based on the results with 25 grasshoppers.

It is apparent from the data in table 4 that "II" residues begin to lose effectiveness after 10 to 14 days and that after 21 days, there is no appreciable toxicity even from the residue on plants sprayed with "II" at 5 lbs. per acre. This high dosage is, of course, about 20 times that necessary to give control.

[1] J. H. Bigger, private communication.

Laboratory Tests.—In addition to the compounds used in field tests, one new chlorinated compound ("III"), an oxygenated derivative of "II", became available for laboratory experiments in 1948. To check the possible synergistic or antagonistic effect of combinations of certain related insecticides, 18 mixtures of chlorinated hydrocarbons were tested in the laboratory in 1948.

The laboratory work was undertaken to determine the LD-50 dosages, both by stomach-poison and contact effect, for each of the six chlorinated hydrocarbons, "III", and the three organic phosphate insecticides used alone, and for the combinations of chlorinated hydrocarbons. For these experiments, adults of *Melanoplus differentialis* were collected in the field from late July until the first of October. These were placed, with an abundance of succulent plants, in a screen house until needed for tests.

Table 4.—Per cent kill of *Melanoplus differentialis* adults caged over alfalfa sprayed with different dosages of "II." Samples exposed in five cages of five grasshoppers each at various intervals after spraying.

Age of Residues in Days	0.25 Lb. Per Acre	1 Lb. Per Acre	5 Lbs. Per Acre
1	92	100	100
5	80	75	100
10	100	92	100
13	48	88	96
17		21	68
22		4	24
Ave. mortality all checks		18 per cent	

Just before being used in tests, each grasshopper was weighed on an analytical balance to the nearest milligram and was then placed into a cage made from a clean, one-pint, cardboard ice-cream container, both ends of which were replaced with screen wire.

For contact tests, measured dosages of the test compounds, dissolved in dioxane, acetone, or ethyl alcohol, were applied to the first abdominal terga by means of a micropipette, which consisted of a 0.5 cc. tuberculin syringe, the plunger of which was moved by a micrometer caliper graduated into thousanths of an inch. Each

division on the micrometer scale delivered 0.000188 ml. of solution. After treatment the insects were returned to the cages, now supplied with suitable food, and the cages were placed on a bench in the greenhouse for the duration of the test.

In the stomach-poison tests, using the same micropipette, measured dosages of compounds dissolved in a suitable, volatile solvent were pipetted on 1-inch circles, cut from leaves taken from unsprayed apple trees. By moving the leaf section as the liquid flowed out of the needle, a fairly uniform deposit could be spread over the leaf disc. After the solvent had evaporated, the treated leaf section was introduced into a cage containing a weighed hopper weight (in grams) was calculated for each individual used in the tests. The results for each compound or combination of compounds were tabulated in ascending order of dosage size, and averages of overlapping groups were plotted on log-probability paper, according to the method of Bliss (1938). As Bliss points out, this method may not be accurate for values near LD-0 and LD-100, but since the curve must rotate around the LD-50 point, that value should be valid, regardless of the slope of the curve. Actually, Richardson's method of averages (Richardson, 1935) was used in projecting the curves, and this method helps to determine also the true slope of the curve. The

Table 5.—LD-50 Values for single compounds tested for contact and stomach-poison effect against *Melanoplus differentialis* adults, expressed as micrograms of toxicant per gram of grasshopper weight.

Compound	Contact		Stomach Poison	
	1947 Results	1948 Results	1947 Results	1948 Results
DDT	>3300.0	9380.0	>1350.0	2579.0
		1339.0[1]		1170.0[1]
Chlorinated camphene	73.9	61.0	75.0	91.5
Chlordan	16.3	9.8	21.8	12.0
γ isomer	1.6	3.4	6.6	6.7
"I"	2.6	1.6	6.0	4.4
"II"		1.8		2.3
"III"		1.4		3.7
Parathion (tech.)	0.7	0.8	6.0	8.9
Tetraethyl pyrophosphate	4.4			
Hexaethyl tetraphosphate	18.4			

[1] Suspension of colloidal DDT. Applied directly to mouth parts in stomach-poison tests.

grasshopper. No other food was available to the insect for a period of 16 to 20 hours. At the end of that time, the remaining leaf fragment, if any, was measured, and the amount of leaf and compound eaten was calculated. Those grasshoppers which consumed only 10 per cent or less of the test circles were discarded.

In all tests the insects were examined and given fresh, unpoisoned food daily for 6 days after treatment. Control insects were given comparable dosages of solvents or untreated leaf circles. All the grasshoppers which died during the period of observation were examined for the presence of parasites or evidence of disease. Diseased or parasitized individuals were eliminated from the records.

At the end of the experiment, dosages were computed in micrograms, and the ratio of toxicant (in micrograms) to grass-

numbers of individuals used in each evaluation in the 1947 experiments varied from 27 to 135, with an average of 59 for contact tests and of 52 for stomach-poison tests. In 1948, larger numbers of insects were used, ranging from 45 to 130 in contact tests, with an average of 93, and from 84 to 202 (average 112) for stomach-poison evaluations. In addition 449 grasshoppers were used for controls.

RESULTS, SINGLE COMPOUNDS.—The LD-50 values shown by both the 1947 and 1948 tests for single insecticides are summarized in table 5. In general the values for the four original chlorinated hydrocarbon insecticides are lower than those reported for these compounds in 1947. In the case of chlorinated camphene, this difference is very probably due to the improvement in the insecticide itself, since only pilot-plant batches of chlorinated

Table 6.—Calculated and observed LD-50 values for mixtures of compounds, 1948 results.

Mixture			Contact					Stomach Poison				
Compound "a"	Compound "b"	Ratio a:b	Theoretical LD-50	Observed LD50	Ratio Theoretical to observed LD-50	% LD-50 of compound "a"	% LD-50 of compound "b"	Theoretical LD-50	Observed LD-50	Ratio Theoretical to observed LD-50	% LD-50 of compound "a"	% LD-50 of compound "b"
DDT	Chlorinated camphene	3:1	239.2	222.0	1.08	1.8	91.0	330.8	232.0	1.43	6.8	63.3
		1:1	121.2	219.0	0.55	1.2	179.5	176.8	225.0	0.79	4.4	123.0
		1:3	81.2	230.0	0.35	0.6	282.8	120.4	211.0	0.57	2.0	173.0
DDT	Chlordan	7:1	77.8	26.4	2.95	0.2	33.7	92.8	49.1	1.89	1.7	50.8
		3:1	39.1	31.1	1.26	0.2	80.6	47.2	41.5	1.14	1.2	86.7
		1:1	19.6	13.8	1.42	0.1	70.4	23.8	16.4	1.45	0.3	68.3
DDT	40% gamma isomer	7:1	67.6	32.2	2.10	0.3	47.1	128.8	86.0	1.50	2.9	64.3
		3:1	33.9	22.0	1.54	0.2	64.7	66.0	38.6	1.71	1.1	57.7
		1:1	16.9	16.9	1.00	0.1	99.4	33.4	65.5	0.51	1.3	195.2
DDT	"I"	7:1	12.8	9.3	1.38	0.1	75.0	34.8	27.2	1.28	0.9	77.3
		3:1	6.4	6.3	1.02	0.1	100.0	17.5	10.3	1.70	0.3	59.1
		1:1	3.2	3.9	0.82	0.0	118.7	8.8	5.1	1.73	0.1	59.1
DDT	"II"	7:1	14.4	6.8	2.12	0.1	47.2	18.4	22.1	0.83	0.8	121.7
		3:1	7.2	5.7	1.26	0.0	77.8	9.2	9.7	0.95	0.3	104.3
		1:1	3.6	3.9	0.92	0.0	85.5	4.6	8.4	0.55	0.2	182.6
Chlorinated camphene	Chlordan	7:1	36.8	34.8	1.06	49.7	45.9	50.4	54.3	0.93	51.9	56.7
		3:1	26.4	23.3	1.13	28.7	59.2	34.4	23.5	1.46	19.2	49.2
		1:1	16.9	14.8	1.14	12.1	75.5	21.2	12.8	1.66	7.0	53.3

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camphene were available for test in 1946. Probably the difference in the effectiveness of chlordan can be similarly explained. There remain, however, several variations which cannot be satisfactorily explained. There are strong indications in the individual data to suggest that there is a definite variation in the vigor of grasshoppers from year to year, from field to field, and even in insects from the same field collected early and late in a single season. The greater susceptibility to insecticides of grasshoppers from certain fields was so apparent that test data on more than 200 individuals in 1947 and approximately the same number in 1948 were discarded. An attempt was made to overcome part of this variation in response to treatment by collecting the test insects only from fields in which there was a low incidence of parasitism and disease, although differences in susceptibility are not necessarily correlated with either of these conditions.

The value of 9380 micrograms/gram for DDT as a contact insecticide indicates that this compound has almost no toxicity to grasshoppers by topical application. The stomach-poison value shows that DDT also is of a low order of toxicity to grasshoppers even when ingested. The much lower values for suspensions of colloidal DDT are almost certainly due to the nonvolatile solvent (presumably one of the alkylated naphthalenes) with which this particular product was formulated.

Although the actual LD-50 values for chlordan and chlorinated camphene are different in the different years of tests, still the ratio of toxicity of these two insecticides remains fairly constant. The fact that field experiments indicate a lower ratio of toxicity (chlorinated camphene: chlordan) must mean that the dosage-mortality curves for these two materials converge toward the LD-100 point. That such is actually the case is illustrated in figure 1, in which the dosage-mortality curves are drawn from our 1948 results on these materials tested as stomach poisons. The curves show that the LD-50 ratio (chlorinated camphene to chlordan) of 7.0:1 does not apply at dosages in the LD-90 to 99 range, where the ratio is 4.4:1 at LD-90 and 2.7:1 at LD-99.

Parathion is the most toxic of the compounds tested by topical application, being twice as toxic as "III", the next most effective contact insecticide. The contact values for "III," "I," "II," and gamma benzene hexachloride are so close that the differences shown in the table may well be due to experimental error. As a stomach-poison, however, parathion is the least toxic of the five most effective compounds, although here again the differences are slight. It should perhaps be pointed out that all of the values in the table indicate

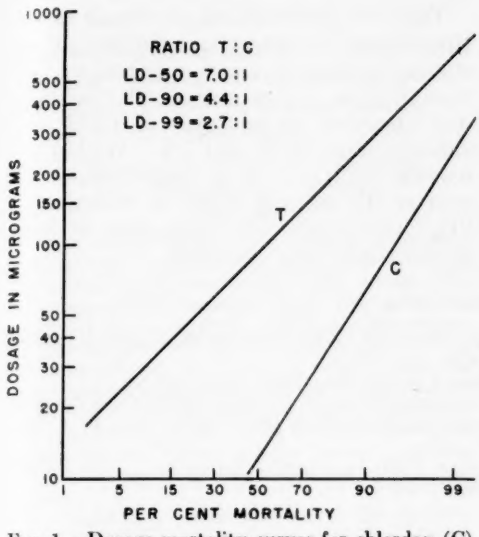

FIG. 1.—Dosage mortality curves for chlordan (C) and chlorinated camphene (T) tested as stomach poisons against adults of *Melonoplus differentialis*.

the average of the LD-50 range, although the graphic method of analysis of data permits the assignment of a definite, single LD-50 value.

RESULTS, MIXTURES OF COMPOUNDS.—The results of tests on combinations of insectides appear in table 6. In this table, the relative effectiveness of the various materials is expressed in several ways. The observed LD-50 values, the actual test results, have little significance by themselves.

The figures for "theoretical LD-50" were calculated from the simultaneous equations, $\frac{a}{\text{LD-50a}} + \frac{b}{\text{LD-50b}} = 100$ and $\frac{a}{b} = r$ where "a" is one of the two compounds in the mixture, "b", the other, and "r", ratio of the two materials in the mixture. By solving for "a" in terms of "b" in the second equation and substitutiong this this value for "a" in the first equation, the amounts of the two materials which together would equal 100 per cent of the LD-50 dosage on the basis of a purely additive effect can be ascertained. The quotients of the theoretical LD-50 values divided by the observed LD-50 values appear in the second, column, "ratio, theoretical: observed LD-50." A value greater than 1.00 indicates, of course, a more-than additive effect, and values less than 1.00 indicate antagonism.

The columns "% LD-50 of compound 'a'" and "% LD-50 of compound'b'" are the quotients (expressed as per cent) of the actual amount of "a" or "b" in the observed LD-50 value for the mixture, divided by the LD-50 value for the compound when used alone. Where the effect is only additive, the sum of these two columns should equal 100.

The results show approximately additive effects for most combinations. Certainly it appears that no outstanding synergism was uncovered by these experiments. DDT and chlordan at the ratio of 7:1 show the greatest over-additive effect, and our field tests indicated that the 7:1 ratio for these material was more effective than the same total amounts of these insecticides used at the ratio of 3:1. The field tests also gave faint evidence of synergism from the use of DDT and "II" at a 15:1 ratio. Although this ratio was not included in the laboratory experiments the 7:1 ratio of these materials in the laboratory showed double the additive effect by contact. This may explain the more rapid (presumably contact) action of the 15:1 combination observed in the LeRoy experiments in comparison with the same amount of "II" used alone.

SUMMARY.—Six chlorinated hydrocarbons and three organic phosphates were tested against grasshoppers in the field. Of these materials, 1,2,3,4,10,10-hexachloro-1:4, 5:8-diendomethano-1, 4, 4a, 5, 8, 8a-hexahydronaphthalene ("II") and 1 (or 3a), 4,5,6,7,8,8-heptachloro-4:7 methano-3a, 4,7,7a-tetrahydroindene ("II") were of outstanding effectiveness at dosages of 2 to 4 ounces per compound per acre. "II" showed a longer residual effectiveness than "I," chlordan, parathion, or gamma benzene hexachloride.

No evidence of repellent action could be detected in plants heavily sprayed with "II" or parathion.

Greenhouse cage tests on residues of "II" on alfalfa indicated that the toxic action of plants sprayed with this compound began to show a reduction after 10 to 14 days and that they lost practically all toxicity to grasshoppers after 21 days.

All of the compounds tested in the field plus an oxygenated derivative of "II" ("III") were included in laboratory tests designed to give the LD-50 values by con-

tact and by stomach-poison effect. Parathion, with an LD-50 value of 0.8 mg. per gram, showed the greatest toxicity by contact effect, followed closely by "III," "I," "II," gamma benzene hexachloride, and tetraethyl pyrophosphate, in that order. In stomach-poison effect, "II" was the most toxic (LD-50 = 2.3 mg. per gram) with "III", "I," gamma isomer, and parathion falling in the same range.

Tests of combinations of certain of the chlorinated hydrocarbons indicated no strong synergism nor antagonism, although some evidence of slight synergism was apparent in mixtures of DDT and chlordan and DDT and "II." Within the narrow limits of this experiment, the greater the ratio of DDT to chlordan or "II," the greater the synergism, at least in contact effect.—12-23-48.

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GREETINGS FROM DR. HERBERT OSBORN

THE OHIO BIOLOGICAL SURVEY
Herbert Osborn, Director
Dwight M. DeLong, Associate Director
Columbus 10

350 S. Interlachen Ave.
Winter Park, Florida
December 30, 1948

Dear Dr. Cory:

I have received, relayed from Columbus, your kind notice of congratulations and the action of the AAES in honoring me with the "Honorary Membership." I certainly feel very grateful for this honor from the society which has been one in which I have been a member for over a half century. Its activities have been one of my principal interests through the years and I have rejoiced in its wonderful growth and importance in national and international affairs connected with our branch of science. I feel that its future is certain to be one of continued progress and important accomplishment. I trust its future history will be one of abounding usefulness.

With my best good wishes to you personally, and with the hope that you have a happy new year and a prosperous year ahead.

Sincerely,
(signed)
Herbert Osborn

SCIENTIFIC NOTES

Chlorinated Hydrocarbon Insecticides for the Control of the Horn Fly on Beef Cattle in Kansas and Missouri

E. W. Laake, *U.S.D.A., Agr. Res. Adm. Bureau of Entomology and Plant Quarantine*

Field tests to compare the value of chlorinated hydrocarbon insecticides for the control of horn flies on beef cattle were made in Kansas and Missouri during the summer of 1947. The tests were conducted in cooperation with the southwestern regional manager of the National Livestock Loss Prevention Board, the extension entomologist, the county agricultural agents, and many beef-cattle feeders or breeders in the two states, together with the State Agricultural College and the State Livestock Commissioner of Kansas and the University of Missouri. All the materials were furnished by the manufacturers.

The insecticides tested were DDT, the methoxy analog of DDT, dichlorodiphenyl dichloroethane, chlorinated camphene, and chlordan. All the materials were as wettable-powder sprays, and DDT was used in toluene emulsion. The materials were applied to the animals at 0.5 per cent concentration except for chlordan, which was used at 0.25 per cent because this chemical was thought to be more toxic than the others. A wettable-powder spray 0.25 per cent of DDT was used as a check.

The materials were applied with power sprayers that maintained a nozzle pressure of 450 to 500 pounds per square inch. Spray booms with triple-driving nozzles were used. With this equipment and pressure the animals could be rapidly and thoroughly drenched with the spray. An average of 2 quarts of spray was applied to each animal at each spraying. The approximate amount of active ingredient applied to each animal was 9 to 10 grams when the concentration was 0.5 per cent. Only beef cattle, nearly all of them Herefords, were used for the tests. The test herds ranged over pastures in localities that differed somewhat, but since all the materials were used in each locality, the tests were uniform and fair for determining the comparative value of all the materials studied.

The initial treatment with all the materials applied at a concentration of 0.5 per cent was made during the first week in June, when horn flies appeared in annoying numbers. The first treatments of chlordan and DDT, at a concentration of 0.25 per cent, were made during the third week in June. By this time the horn fly population had built up to 600 or more per animal. The sprayed herds were observed closely at 3- to 4-day intervals, and when the fly population averaged more than 25 flies per animal, the herd was re-treated. Some of the Kansas herds were marketed before the end of the horn fly season, but most of them received at least three treatments, or remained in the test throughout the season. The average horn fly population on the Missouri herds was consistently lower than that on the herds in Kansas. The herds in Missouri were less exposed to untreated herds than were those in Kansas.

With the concentrations and formulations used, and the intervals at which they were applied, none of the materials were injurious to cattle or to the spray operators. However, since only incidental observations on the toxicology of the new materials were made in connection with these tests, no conclusions can be drawn regarding their potential hazards. Statements regarding their effectiveness in controlling the horn fly should therefore not be construed as recommendations for their use.

The results of these tests, as shown in Table 1, indicate that—

Table 1.—Control of horn flies on beef cattle with various chlorinated hydrocarbon insecticides. (Wettable-powder sprays at 0.5 per cent concentration unless otherwise indicated.)

Material	Location of Test	Number of Treatments	Average Number of Animals Treated	Average Days' Protection
DDT:				
Wettable powder	Kansas	4	493	30
	Missouri	2	82	45
Emulsion	Kansas	4	356	28
	Missouri	2	39	48
Methoxychlor	Kansas	4	206	24
	Missouri	3	158	47
Dichlorodiphenyl dichloroethane	Kansas	4	325	25
	Missouri	3	42	50
Chlorinated camphene	Kansas	4	220	27
	Missouri	3	33	42
Chlordan, 0.25 per cent Kansas	Kansas	4	97	17
DDT, 0.25 per cent (check)	Kansas	4	139	19
	Missouri	2	39	29

(1) All the new chlorinated hydrocarbon insecticides are excellent for horn fly control.

(2) In Kansas DDT, both as a wettable powder and as an emulsion, was slightly superior to the methoxy analog of DDT, dichlorodiphenyl dichloroethane, and chlorinated camphene at 0.5 per cent concentration, and to chlordan at 0.25 per cent; in Missouri, where smaller numbers of animals were treated, DDT was slightly less effective than dichlorodiphenyl dichloroethane.

(3) All the materials tested gave a longer period of protection in Missouri than in Kansas. As stated above, the Missouri test herds were less exposed to untreated cattle than were the Kansas herds. In previous years, and again during this year, it was observed that this factor greatly influences the length of time that the residue remains active. It is rather definitely indicated, therefore, that fewer treatments are required, regardless of the residual insecticides used, as long as the treated herds are well isolated or surrounded by treated herds.

Recent Collections of Colorado Fleas

RICHARD B. EADS, *Bureau of Laboratories, Texas State Department of Health, Austin*

Dr. W. B. Davis, Head of the Fish and Game Department, Texas Agricultural and Mechanical College and a group of his students made collecting trips to Colorado during the summers of 1947 and 1948. Many of the mammals taken were examined for ectoparasites. The specific identifications of the Siphonaptera are presented in this paper.

The host determinations were made by Dr. W. B. Davis, Mr. Frank M. Prince C.D.C. Activities, U. S. Public Health Service, San Francisco, California, checked and identified several of the specimens.

June and July, 1947

Thomomys talpoides—Pocket Gopher—3 specimens
21 *Foxella ignota* (Baker)
Park County (W. B. Davis, J. T. Willis, R. L. Schultz)

Citellus richardsoni—Ground Squirrel—2 specimens
1 *Hystrichopsylla gigas* (Baker)
Park County (W. B. Davis)

Citellus variegatus—Rock Squirrel—1 specimen
10 *Diamanus montanus* (Baker)
Pueblo County (W. B. Wilson)

Eutamias minimus—Chipmunk—2 specimens
2 *Opisocrostis labis* (Jordan and Rothschild)
2 *Monopsyllus eumolpi* (Rothschild)
Park County (W. B. Davis)

Cynomys gunnisoni—Gunnison Prairie Dog—2 specimens
15 *Oropsylla idahoensis* (Baker)
4 *Opiscrostis tuberculatus* (Baker)
Park County (W. B. Davis, J. T. Willis, E. G. Simmons)

Neotoma cinerea—Wood Rat—3 specimens
19 *Orchopeas sexdentatus* (Baker)
Park County (W. B. Davis, J. T. Willis, E. G. Simmons)

Sylvilagus nuttallii—Cottontail—2 specimens
32 *Cediopsylla inaequalis* (Baker)
7 *Odontopsyllus dentatus* (Baker)
Park County (W. B. Davis)

June and July, 1948

Marmota flaviventris—Woochuck—1 specimen
4 *Thrassis standfordi* Wagner
Eagle County (J. M. Inglis and B. C. Nichols)

Citellus richardsoni—Ground Squirrel—2 specimens
30 *Cropsylla idahoensis* (Baker)
Eagle County (B. C. Nichols and B. D. Oliver)

Citellus lateralis—Ground Squirrel—1 specimen
6 *Oropsylla idahoensis* (Baker)
Park County (T. D. Carroll)

Ochotona princeps—Cony—1 specimen
1 *Ctenophyllus terribilis* (Rothschild)
1 *Thrassis stanfordi* Wagner
Eagle County (B. C. Nichols and J. M. Inglis)

Flea Beetles Attacking Cruciferae

S. W. FROST[1,2]
State College, Pa.

Six species of flea beetles have been associated with Cruciferae in Pennsylvania; *Phyllotreta aerea* Allard, *Phyllotreta striolata* (F.) (=*vittata* F.), *Phyllotreta zimmermanni* (Crotch) *Psylliodes punctulata* Melsh., *Epitrix cucumeris* Har., and *Chaectonema pulicara* Melsh. *Phyllotreta aerea* was commonly found on cabbage, turnip and radish while *P. striolata* was more frequently found on wild Cruciferae. *P. zimmermanni* has been taken only occasionally in Pennsylvania. The hop flea beetle *Psylliodes punctulata*, the potato fleabeetle *Epitrix cucumeris* and the corn flea beetle *Chaectocnema pulicara* were infrequently found on Cruciferae.

METHOD OF SAMPLING FLEA BEETLES. Collections were made once a week with an ordinary 12-inch sweeping net. The methods of planting and types of growth of the different hosts did not permit a uniform procedure of securing samples. Ten complete sweeps were made over the tops of yellow rocket *Barbarea vulgaris* so that the insects were gathered from the flowers and upper parts of the plants from an area where these insects predominated. The beetles were beaten from 10 cabbage plants by holding the net close to the ground. In the case of radish, the net was swept up and down a 60 foot row or plants with a strong but steady stroke. A similar method was used for turnips but the row was only 30 feet long and the net was swept in one direction only. Therefore the relative figures for catches from turnip in table 2 are much larger than indicated. Not all the flea beetles, by any means, were captured from the plants during the weekly collections. The populations, as will be seen, were never noticeably reduced by methods of sampling. Many of the beetles dropped to the ground and escaped. Sticky fly paper placed on the ground would have insured a larger catch. In each case the insects were shaken to the bottom of the net and transferred to a cyanide bottle for killing. They were then taken to the laboratory for separation and identification.

Weekly collections from cabbage and radish during 1947 were made on the same days and are directly comparable. Those made from different hosts during 1948 were not taken the same days. Various conditions made this impossible. The radishes were removed long before the flea beetle population had reached its peak. They were also planted early and developed before yellow rocket was suitable for sweeping. Late collections from rocket were im-

[1] Dr. L. E. Dills aided in the collections of 1947 and Mr. C. L. Hamrum did most of the sweeping in 1948.

[2] Authorized for publication on February 28, 1949 as paper No. 1515 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

Table 1.—Flea beetles collected from Cruciferae, State College, May 12–26, 1947.

Host	Total Number Flea Beetles	Per Cent of Total Flea Beetle Catch		
		Phyllotreta aerea	*Phyllotreta striolata*	*Psylliydes punctulata*
Cabbage	765	97.5	1.0	1.4
Radish	783	93.9	5.6[1]	.3

[1] All taken on May 13.

practical because the adjacent weeds grew to such a height that one could not sweep the desired plants without capturing many insects from the surrounding area. Furthermore, after the production of seed, the rocket began to decline. The infestation on turnip became so heavy towards the end of July that the plants were severely injured. This in turn contributed to a reduction of the flea beetle population. The collections of *Phyllotreta aerea* on July 15 and 17 were 412 and 429 respectively. On July 20 and 22 they had dropped to 376 and 377. On July 27, 29 and August 2 they were 241, 146 and 125. It is believed that this decline does not represent a normal reduction in flea beetle population but resulted from the severe injury inflicted on the plants.

Identity of *Phyllotreta aerea*. Since this species is not generally known by entomologists a few words concerning its habits and distinguishing characteristics may not be amiss. It is a European species that was first noticed in North America about 1926. At that time F. H. Chittenden reported injury to radish seedlings at Rochester, N. Y. In 1920 it was doubtfully recorded from Michigan attacking cabbage, radish and Swedish turnip. It was observed at State College, Pa. as early as 1938. Records in the U. S. National Museum indicate that this flea beetle was found on cabbage at Albion, N. Y. in 1939. Mr. E. J. Udine noticed this beetle at Carlisle in 1942 attacking cabbage and radish. He also collected the larvae mining the leaves of *Lepidium campestre*. It is well known that the larvae of *Phyllotreta* mine in leaves or feed on roots. Frequently the adults attack plants other than those on which they breed. No doubt this species is common in other parts of the East but has been generally overlooked.

Phyllotreta aerea is a small, shiny black beetle about 2.2 mm. long. The upper surface of the body is smooth but marked by numerous delicate punctures which are more distinct towards the posterior end of the elytra. The basal three segments of the antennae, the base of the tibiae and the tarsi are brown. It is somewhat closely related to two western species which also attack Cruciferae; the western black flea beetle *P. pusilla* Horn and the so called cabbage flea beetle *P. albionica* Le Conte. *P. pusilla* is cupreous brown in color while *P. albionica* is shiny, metallic green.

In the spring *Phyllotreta aerea* attacks young plants causing much injury and preventing them from getting a good start. During the summer they continue feeding and increase in numbers as the season progresses. Radish, turnip and young cabbage show larger populations durng the summer than older cabbage plants Damage to mature cabbage is especially noticeable in the late fall when the beetles congregate for hibernation. They eat small holes through the upper epidermis but do not chew through the leaf. Although each beetle eats a minute area, the total injury from many beetles often covers a large part of the leaf. Extensive sweepings of tomato and egg plant revealed no *P. aerea* although other species were taken in large numbers.

It is interesting to note that most text books emphasize the striped flea beetle *Phyllotreta striolata* as the comon cabbage species in the East. The accompanying data indicate that in Pennsylvania, and perhaps other parts of the Eastern United States, *P. aerea* is the principal species attacking radish, cabbage and turnip and that *P. striolata* is more closely associated with wild Cruciferae. Undoubtedly there has been much confusion in economic literature concerning the identity of the species of *Phyllotreta* attacking Cruciferae. This is especially true of the striped species which superficially look much alike. *P. zimmermanni*, chiefly a southern species has been taken at Carlisle, Lancaster and Tobyanna, Pa. *P. bipustulata* Fab., another striped species, commonly found on yellow rocket in eastern United States, has been collected from Lancaster.

Other Species of Phyllotreta Attacking Cruciferae. In western United States and Canada, *Phyllotreta pusilla* and *P. albionica* seem to be the common cabbage species. They are coppery or greenish beetles without yellowish lines. The adults of *P. oregonensis* Crotch, known only from Oregon, attack turnip, radish and wild Cruciferae. The larvae mine the leaves of *Lepidium*. *P. utana* Chittenden is another western species which has been taken on mustard and beet. *P. undulata* Kutsch is a northern species feeding chiefly on mustard. Three species have been recorded chiefly from the southern United States: *P. zimmermanni*, *P. liebecki* Schaef, and *P. aenicollis* Crotch.

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Table 2.—Flea beetles collected from Cruciferae, State College, 1948.

Host	Dates	Total Number Flea Beetles	Per Cent of Total Flea Beetle Catches			
			Phyllotreta aerea	*Phyllotreta striolata*	*Psylliodes punctulata*	*Epitrix cucumeris*
Rocket[1]	June 8–July 14	253	7.1	91.3	.7	2.7
Radish	May 25–June 17	275	63.6	4.0	29.4	2.9
Turnip	July 14–Aug. 2	2662	94.4	5.1	.4	.0

[1] *Barbarea vulgaris*.

Thrips Infesting Tomatoes and Their Occurrence on Other Hosts

DARRELL R. MADDOCK,[1] *Utah State Agricultural College, Logan*

Thrips are important tomato-infesting insects in northern Utah. However, the principal concern over thrips occurring in tomatoes relates to the food processor. He is concerned when they appear in canned tomatoes and tomato products. It was believed that a more complete knowledge of the species of thrips infesting tomatoes, and of their other host plants might enable tomato growers to eliminate many such plants from tomato fields and to reduce such occurrence on adjacent lands.

Fifty-two collections of thrips were made from tomato plants, *Lycopersicon esculentum*, in northern Utah during this study. *Frankliniella moultoni* Hood (=*occidentalis* Perg.) was present in 45 of the 52 collections; *Aeolothrips fasciatus* (L.) in 18; *Thrips tabaci* Lind. in 13; *Anaphothrips obscurus* (Mull.) in 3 and *Microcephalothrips abdominalis* (Crawf.) in only one of the collections.

A total of 378 collections were made from 109 plants representing 39 plant families.

Frankliniella moultoni was found on one or more plants in nearly every plant family from which collections were made. This thrips was collected from nearly every species of Leguminosae and from every species of Compositae and Solanaceae examined. It seemed to show some preferance for plants of these three families.

Aeolothrips fasciatus is predaceous and was collected from a wide range of plants. It appears that the kind of plant is of less importance than the occurrence of numerous other thrips on which this species preys.

Thrips tabaci also has approximately as wide a host range as does *F. moultoni*. This species also was taken from hosts representing every plant family in which more than one species of plant was examined. It was collected from potato and eggplant which are close relatives of the tomato.

Anaphothrips obscurus was collected from only four different species of plants in addition to tomatoes. Three of these species of plants belonged to the family Gramineae. This thrips seems to have a host specificity for members of the grass family. The collections from tomato and the one from a composite probably were accidental.

Microcephalothrips abdominalis was collected four times on plants other than tomatoes. Three collections were made from two different species of plants in the family Compositae. In one instance this species of thrips was present on *Sambucus* sp. of the family Caprifoliaceae. This latter collection and the ones from tomatoes were probably accidental.

Frankliniella moultoni, *Thrips tabaci*, and *Aeolothrips fasciatus*, the species of thrips commonly occurring on tomatoes in Utah, each have a very wide host range with representatives in almost every family of plants common to northern Utah. The lack of host specificity of these three prolific species makes their effective control by weed eradication and selection of neighboring crop plants particularly difficult. However, the abundance of these thrips in tomato fields probably can be reduced by more general attention to weed control.

[1] The writer expreases his appreciation to Dr. G. F. Knowlton, Professor C. J. Sorenson, and W. E. Peay for suggestions and cooperation during the course of the investigation; to Dr. S. F. Bailey and J. C. Crawford for identifications and suggestions on taxonomy. The Knowlton collection of Utah thrips, identified by the late Professor J. R. Watson, was of substantial help in this investigation.

The Value of Phenyl Ethyl Acetate as an Ingredient in Japanese Beetle Baits

GEORGE S. LANGFORD and ENGEL GILBERT
University of Maryland, College Park

Traps are used rather extensively in Maryland in Japanese beetle control work. Prior to the war a mixture consisting of geraniol, 9 parts, and eugenol, 1 part, was the recommended attractant for use in traps. During the war geraniol became scarce and was not available at reasonable prices. Therefore it was necessary for workers to study other chemicals as possibilities for replacement or partial replacement for geraniol.

Fleming & Chisolm (1944) suggested anethole as a substitute for geraniol. Muma *et al.* (1945) suggested the possibility of caproic acid diluted with mineral oil as a partial replacement. Langford & Cory (1946) showed that caproic acid and phenyl ethyl butyrate could be used either wholly or partially to replace geraniol in certain bait combinations.

In an attempt to improve these known bait combinations as well as to develop new ones the writers have experimented with a large number of chemicals. Data collected over a period of 3 years shows that phenyl ethyl acetate has value in improving the attractive qualities of baits made with geraniol and eugenol or anethole and eugenol. The relative value of phenyl ethyl acetate in several baits prepared with geraniol and eugenol, as well as anethole and engaged is given in Table 1.

Table 1.—Results from phenyl ethyl acetate in Japanese beetle baits.

Bait	No. of Replications	Beetles Caught	Relative Efficiency
When attractive value of Geraniol, 9 parts, and Eugenol, 1 part, is 100			
Phenyl ethyl acetate, 8 parts Eugenol, 1 part Geraniol, 1 part	12	129,411	108%
Phenyl ethyl acetate, 8 parts Eugenol, 2 parts	4	130,779	72
Phenyl ethyl acetate, 8 parts Geraniol, 2 parts	4	126,123	84
Geraniol, 8 parts Eugenol, 1 part			
Phenyl ethyl acetate, 1 part Eugenol, 9 parts	44	1,167,158	130
Phenyl ethyl acetate, 1 part	35	873,147	99
When attractive value of Anethole, 9 parts, and Eugenol, 1 part, is 100			
Anethole, 8 parts Eugenol, 1 part Phenyl ethyl acetate, 1 part	35	516,422	133

As a major constituent, phenyl ethyl acetate made a satisfactory ingredient when used in combination with geraniol and eugenol. A formula consisting of phenyl etyhl acetate, 8 parts, gernaiol, 1 part, and eugenol, 1 part, was equal to, or better than, the well known formula consisting of geraniol, 9 parts, and eugenol, 1 part. Used with either geraniol or

eugenol alone the attractive value was fair but somewhat less than the geraniol-eugenol standard.

As a minor ingredient, phenyl ethyl acetate improved attractiveness in both geraniol-eugenol and anethole-eugenol combinations.

A formula consisting of geraniol, 8 parts, eugenol, 1 part, and phenyl ethyl acetate, 1 part, proved superior to the standard formula of geraniol, 9 parts, and eugenol, 1 part. The relative value of the bait containing phenyl ethyl acetate was 130 as compared with 100 for the geraniol-eugenol bait.

Standard anethole-eugenol baits were greatly improved by adding phenyl ethyl acetate. A formula consisting of anethole, 8 parts, eugenol, 1 part, and phenyl ethyl acetate, 1 part, had a value of 133 as compared with 100 for a formula consisting of anethole 9 parts and eugenol, 1 part.

METHODS AND VALUES—Data on all, bait mixtures reported in these studies were obtained under field conditions with traps and equipment other than bait mixtures, identical. The traps were arranged in batteries and spaced at intervals of approximately 8 feet. Each test trap was accompanied by a check. The position of all traps was changed daily by rotation. The relative values are expressed on the basis that the value for the check traps is 100.

European Fruit Lecanium on Peach Following Applications of DDT

DEAN ASQUITH,[1] *The Pennsylvania Fruit Research Laboratory*

On Aug. 2, 1948 an Arendtsville fruit grower brought to the laboratory some specimens of blackened peaches. Inspection of the orchards from which the peaches were taken revealed that several blocks of trees were heavily infested with European fruit lecanium, *Lecanium corni* Bouché,[2] which were secreting honeydew that was showering down onto foliage and fruits. Blackening of the peaches and foliage was caused by the appearance of sooty mold growing in these deposits of honeydew.

Infestations of European fruit lecanium of varying degrees of severity were found in other peach orchards in the vicinity of Arendtsville. In all cases adult scales were found on 1948 growth as well as on older wood, a fact which indicates either that there had been a hatch of eggs earlier in the season or that some of the overwintering scales had moved to new growth. The orchards infested with European fruit lecanium had all received one or more applications of DDT for the control of other insects, and several of the orchards had been treated with benzene hexachloride to control the plum curculio.

To support the tentative accusation of DDT and possibly benzene hexachloride as causes for the sudden outbreak of the European fruit lecanium in the Arendtsville area, there are two more pieces of circumstantial evidence. Large numbers of adult scales were found on numerous weeds, but in every case the weeds were growing inside orchard areas that had been sprayed with DDT alone or DDT and benzene hexachloride. Investigators previously located at the Pennsylvania Fruit Research Laboratory had observed the European fruit lecanium in peach orchards before growers began to use DDT and benzene hexachloride, but the scales were always so heavily parasitized that infestations of them were not of economic importance.

Regardless of the reason for the 1948 infestation, it was apparent that several growers would suffer heavy losses unless a treatment to prevent further deposits of honeydew could be found. Therefore, on August 3 a quick test was arranged by dividing a block of infested peach trees into four plots. Plot 1 was treated with a 25 per cent DDT emulsion[3] at the concentration of 1 quart per 100 gallons of spray; plot 2 with 1 quart of 40 per cent nicotine sulphate[4] plus 4 ounces of wetting agent[5] to 100 gal.; plot 3 with 1.3 pints of a mixture of 9 per cent tetraethyl pyrophosphates and 41 per cent other organic phosphates,[6] in 100 gallons; and plot 4 was not treated.

Maximum and minimum temperatures on August 3 were 78° F. and 63° F. respectively; on August 4 74° F. and 65° F.; and on August 5, 82° and 62°. After application of the sprays on August 3, the nicotine sulphate—wetting agent treatment stopped honeydew secretion almost completely within two hours. DDT emulsion slowed honeydew secretion appreciably within 48 hours, but not so well as did the nicotine sulphate. The organic phosphate mixture was not effective enough to warrant further consideration for this special problem.

Since the grower was in a hurry to prevent honeydew secretion in his peach orchards, he decided to apply nicotine sulphate and wetting agent when the weather was suitable and DDT emulsion during periods of cooler temperatures. It soon became apparent, however, that nicotine sulphate wetting agent was enough more effective than DDT at preventing honeydew secretion to warrant waiting for favorable weather to make the applications.

In the meantime, an attempt was made to correlate results obtained in the test plots with kill data, but no appreciable differences in mortalities were obtained. Nicotine sulphate wetting agent continued to prevent honeydew secretion almost completely until August 14 at which time some scales in this plot began to secrete. After the initial slowdown of honeydew secretion in the DDT plot, there was no improvement.

On August 16 all the plots were sprayed with nicotine sulphate combination at the concentration mentioned above. Again honeydew secretion ceased a short time after the application, and in the original nicotine sulphate plot no new deposits of honeydew were seen during the rest of the season. This observation was verified in other parts of the orchard which received two applications of the nicotine sulphate spray.

Throughout the season other data were collected on the European fruit lecanium; in fact, observations are still being made from time to time. Eggs were counted in the following manner. The eggs from a known number of scales were brushed onto a piece of paper. Then the eggs were run through the brushes of a "mite machine" onto a circular glass plate moistened with alcohol. A circular piece of paper the same size as the glass plate but marked into eight equal segments was placed under the glass plate. Eggs within the area of one of the segments were then counted through a binocular microscope.

[1] Acknowledgement is made of the valued assistance of Nelson F. Kane, Edgar M. Raffensperger and Harvey W. Dickert.

[2] Identified by Dr. Harold Morrison of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, U.S.D.A

[3] Manufactured by Rohm and Haas Co.

[4] Black Leaf 40, Tobacco By-Products and Chemical Corp.

[5] Triton B-1956, Rohm and Haas Co.

[6] Vapotone, California Spray-Chemical Corp.

This count was multiplied by eight and the result divided by the known number of scales to find the average number of eggs.

From August 14 to 16 the eggs from 25 scales were counted. The average was 950 eggs per scale. On August 20 newly hatched scales were first seen in the field. A few adult scales were collected from these trees and taken to the laboratory. Scales were selected beneath which the eggs were ready to hatch, but as far as could be determined none had hatched. The average count for 13 scales was 1417 eggs per scale. These counts were made merely to get some idea of the reproductive powers of the European fruit lecanium in south central Pennsylvania.

In orchards, hatching of eggs covered the period from August 20 to September 15. The young moved to the leaves, most of them settling on the undersides along the mid-ribs. Only an occasional young scale was found that had settled on a twig. Later young scales only were observed on leaves of cherry, both sweet and sour, and apple near infested peach orchards. Indications are that these young scales were disseminated by air movement.

During the season adult scales were observed on 24 plants, vines and trees among which were 16 weeds that had made all their aerial growth in 1948. This last point is another indication that either there had been a hatch of eggs early in the season or some of the overwintering scales had moved to new growth. Young scales were observed on all these plants and on an additional eight. Included among the eight plants on which only young scales were seen were apple, sour cherry and sweet cherry as just mentioned.

Young scales were seen moving back to the wood for the first time on Oct. 4, but this movement did not become general until Oct. 20. Oct. 16 was the date of the first frost, and on Oct. 19 the minimum temperature was 27° F. A short time after settling on the wood the young scales turned brown in color; a condition which together with their small size makes them difficult to detect.

On the basis of circumstantial evidence only, the current infestation of the European fruit lecanium in the Arendtsville area illustrates again the type of problem entomologists are apt to encounter during periods when new insecticides are being introduced into spray schedules.[1]

New Insecticides for Tobacco Flea Beetle Control

C. B. DOMINICK, *Bright Tobacco Field Station, Chatham, Va.*

Several organic insecticides were tested during the spring of 1947 in tobacco plantbeds for the control of the tobacco flea beetle, *Epitrix hirtipennis* (Melsh.). DDT proved to be highly effective against this insect in 1946 (Dominick 1947); however several new materials, some not previously tested against the tobacco flea beetle, were included in the 1947 experiments.

MATERIALS.—The materials used in the experiments were as follows: a wettable powder[1] containing 50 per cent DDT; a 3 per cent DDT dust;[2] a wettable powder[3] containg 5 per cent gamma isomer of benzene hexachloride and 37 per cent of other isomers; a wettable powder[4] containing 25 per cent chlorinated camphene; a wettable powder[5] containing 50 per cent chlordan; a wettable powder[6] containing 50 per cent bis (methoxyphenyl) trichloroethane and the fungicide ferric dimethyldithiocarbamate[7] said to be 70 per cent active.

TOBACCO PLANT BEDS.—The insecticides were tested at three locations and each treatment was replicated a total of five times. A complete randomized-block design was used, the tobacco plant beds being arranged in pairs at two locations and singly at the third. Each plot was 3 yards in length and 2 yards wide.

The sprays were in combination with the fungicide and were applied with compressed-air sprayers at the rate of 3 gallons per 100 square yards of plant bed area for the first and 4 and 5 gallons respectively for the two subsequent applications. The insecticides were added at intervals in the regular spray schedule for controlling downy mildew. The 3 per cent DDT dust was applied separately from the fungicide treatment with a rotary-type hand duster. The effect of drifting was largely prevented by the use of covers placed over the plot on each side of the one being dusted. The dust was applied at the rate of 8 ounces for the first and 1 pound for each of the two subsequent applications per 100 square yards. Treatments were made when the plants were in the two- to four-leaf stage, when they had attained a height of 2 to 3 inches, and just after the plant bed covers were removed for hardening the plants.

Table 1.—Comparative tests on the control of the tobacco flea beetle in tobacco plant beds with organic insecticides, 1947.

Treatment	Plants per Square-Foot Sections		Uninjured Plants Per Cent
	Uninjured	Injured	
DDT 1 lb., fungicide 3 lbs., water 100 gals.	594	9	98
DDT 8 ounces, fungicide 3 lbs., water 100 gals.	473	30	94
Methoxychlor 1 lb., fungicide 3 lbs., water 100 gals.	472	43	91
Chlorinated camphene 1 lb., fungicide 3 lbs., water 100 gals.	584	33	94
Benzene hexachloride 2 ounces gamma isomer, fungicide 3 lbs., water 100 gals.	440	29	94
Chlordan 1 lb., fungicide 3 lbs., water 100 gals.	484	77	86
DDT 3% dust	486	61	89
Check	99	467	17

The results were determined on May 21, when most of the plants had attained a height of 6 inches. An area 12 inches in width was left as a buffer space along all four edges of each plot. Two random samples consisting of all the plants in an area of 1 square foot was taken from each plot. During examination, if a plant had one or more holes in a leaf resulting from flea beetle feeding, it was recorded as injured.

The results of this experiment are summarized in table 1. These data indicate that all materials were effective in controlling the tobacco flea beetle in plant beds. No new insecticide under investigation

[1] *S-W* 50% DDT.
[2] *S-W* 3% DDT dust.
[3] *Gammaloid.*
[4] *Toxaphene.*
[5] *Velsicol 1068.*
[6] *Methoxychlor.*
[7] *Fermate.*

proved to be superior to DDT at the rate of 8 ounces to 1 pound of the active ingredient in 100 gallons of water when combined with the fungicide. Benzene hexachloride at the relatively low concentration of 2 ounces of the gamma isomer to 100 gallons of water injured approximately 25 per cent of the plants. Chlorinated camphene, *methoxychlor*, 3 per cent DDT dust, and chlordan gave good protection without injury to the plants.

PRE-TREATMENT.—Investigations during 1946 revealed that DDT when applied in the plant bed prior to transplanting was about as effective as when the insecticide was applied directly in the field. The purpose of the following experiment was to compare DDT with several other insecticides, all materials being applied in the plantbed a few hours before the plants were pulled for transplanting. The plants had received the same treatment during the course of the plant bed season. Approximately 1.5 inches of rain occurred between the date of the last plant bed treatment and May 22, the date the plants were pulled for transplanting. The sprays were applied at the rate of 5 gallons and the dust at the rate of 1.5 pounds per 100 square yards of plant bed area.

Tobacco plants treated in this manner were set in seventieth-acre plots and each treatment was replicated five times in randomized blocks. The check plots were set from an area in which the tobacco flea beetle had been kept under control by the use of rotenone dust; however no pre-treatment was applied. The results were determined by making a count of live flea beetles on 12 random plants selected from the two center rows of each plot, 3, 6, and 12 days following transplanting. A count of all feeding punctures on the most obviously injured leaf was made on 12 random plants selected from the two center rows of each plot, 13 days after the setting date.

The results are presented in table 2. These data indicate that a pre-treatment of tobacco plants in the plant bed prior to transplanting is a highly satisfactory method of controlling the tobacco flea beetle on newly set plants. Such a method saves time and labor involved in making field treatments. The data further indicate that the new insecticides under investigation were not superior to DDT when used at the same rate and under similar conditions. No chemical injury resulted from the use of the treatments except for benzene hexachloride. Plants treated with this material, 2 ounces of the gamma isomer, showed slight injury; however they later grew out of this condition. Treated plants were all farther advanced than the checks at the end of the 14-day observation period. Leaf puncture counts on the most obviously injured leaf indicated that DDT offered superior protection. Plants treated with DDT, 1 pound in 100 gallons of water, showed an average of 27 punctures on the most obviously injured leaf, while chlordan at the same rate had an average of 66. The checks, on the other hand, showed an average of 122 punctures.

PHYTOTOXICITY.—Small scale phytotoxicity tests were carried on with DDT at three rates and with benzene hexachloride, used at the rate of 2 ounces of the gamma isomer, all being in combination with the fungicide in tobacco plant beds. The plots were 1 square yard in area and each treatment was replicated three times. A check sprayed only with the fungicide was left in each series for comparison. Seven applications were made during the period from April 25 to May 27.

The plants were examined at intervals and notes made on the amount of chemical injury occurring. There was apparently no chemical injury from the use of DDT 1 pound and fungicide 3 pounds in 100 gallons of water after seven applications. DDT 2 pounds with fungicide caused slight injury after the third application as noted on May 6, while DDT at the rate of 4 pounds with the fungicide caused more extensive injury. No injury attributed to DDT was noted on any treated plants on May 27 and all replications compared equally in growth and appearance with the checks. At least 40 per cent of the plants treated with benzene hexachloride were affected by the treatment and showed moderate injury on May 27.

Table 2.—Pre-treatment tests with organic insecticides against the tobacco flea beetle, on newly set tobacco, 1947.

TREATMENT	FLEA BEETLE POPULATION — DAYS AFTER APPLICATION 3	6	12	AVERAGE LEAF PUNCTURES, MOST OBVIOUSLY INJURED LEAF, 13 DAYS	PER CENT REDUCTION 3 DAYS
DDT 1 lb., fungicide 3 lbs., water 100 gals.	7	55	32	27	98
Methoxychlor 1 lbs., fungicide 3 lbs., water 100 gals.	10	160	118	49	97
Chlorinated camphene 1 lb., fungicide 3 lbs., water 100 gals.	22	165	84	39	94
Benzene hexachloride 1 lb., fungicide 3 lbs., water 100 gals.	37	122	105	33	90
Chlordan 1 lb., fungicide 3 lbs., water 100 gal.	185	265	193	66	65
DDT 3% dust	29	145	111	33	92
Check	350	544	335	122	—

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New Developments in the Transport of Beneficial Insects

J. LINSLEY GRESSITT[1] and S. E. FLANDERS[2]

The biological control of insect pests through the introduction of their natural enemies has been greatly facilitated by the development of commercial air transport because of the reduction of time in transit (Compere, *et al*, 1941).

Efficient utilization of air transport has necessitated radical changes in methods of handling shipments of living insects. Bulk shipments are now avoided if possible. Personally conducted shipments are not often necessary. Small shipments frequently made is now the rule. This procedure minimizes the loss when a shipment miscarries or is destroyed. In addition, repeated introductions increase the chances of successful propagation and establishment of an introduced species.

Since the time in transit from almost any part of the world is now less than the life cycle of any insect likely to be involved, there is no need for transporting the host plant in order to maintain cultures of the insect Likewise the time in transit is less than the life span of many adult insects so that cold storage facilities are no longer necessary for the transport of adult insects.

Maintenance of environmental conditions during transit suitable for the continued development of immature insects and for the survival of adults is still essential. The packaging of the imported material so that nothing can escape en route remains of utmost importance.

Although the cost per unit of weight and volume of shipping by air is much greater than that by other means of transportation, the cost per beneficial insect received alive is much less.

During the past year the senior author and his assistants have sent to Riverside, California, from China over a hundred shipments of the parasites and predators of various pests of citrus. The minimum time in transit was 5 days from Canton and 7 days from Chungking.

All the entomophagous insects sent by air were contained in manila envelopes, 12″×8″. To protect this material from desiccation and from injury by rough handling it was enclosed in small but durable boxes made of the root of the water pine, *Glyptostrobus pensilis*.[3] Hoffmann (1930) discusses the use of the water pine root as a substitute for balsa wood in entomological work. It is used locally in Canton for bottle stoppers and life-saver floats. The root wood varies in weight from about 7 to 11 pounds per cubic foot including knots and bark, the specific gravity being 0.115 to 0.180. In appearance and quality the wood varies considerably from pale gray and easy to work to brownish gray and brittle.

Small containers in the form of flat rectangular boxes made of this wood are exceptionally suitable for shipping small amounts of material by air mail. The wood is light in weight and spongy, but quite tough. To date, no box has broken in transit in spite of being thin-walled and practically unprotected. The wood is highly moisture absorbent so that it is necessary to coat the inner surfaces of the containers with shellac to retard desiccation of the enclosed material. The texture of the wood is such that it may serve to some extent as insulation against high temperatures.

The boxes are made simply by cutting a cavity in an oblong slab of wood and by cutting a thin section of it to form a cover for the opening. This cover is perforated with a small opening so that live insects may be readily placed in the box without their escaping in the process. The opening is then closed with a cork. The cover and the cork are secured in place by scotch tape. As security against the escape of insects from the boxes, each box is tied up within a bag made of durable, tightly woven cloth.

When ready for mailing, the envelope carries the government shipment permit of the country of destination. The time of transit may be shortened if the envelope also carries a special delivery stamp of the country of destination and appropriate telephone numbers so that notification of its arrival can be made immediately by the post office personnel.

Food is usually provided for the insects during transit. For adult parasites fine streaks of undiluted honey may be put on the inside of the cover of the box. For adult ladybird beetles one or more whole washed raisins are securely fastened by pins in the corners of the box, the raisins being split to facilitate feeding. For larval ladybird beetle some of the natural food should be included, in addition to a raisin. With parasitized scale insects, sufficient host plant material may be included in the boxes to keep the insect hosts alive for at least part of the time required to reach the destination.

With species having host plants that may not be legally shipped to the desired destination, the insects must be removed as carefully as possible, either being placed directly in the box or at first in a petri dish or on a sheet of smooth paper. Most scale insects may be removed from the host by pressing against the edge of the scale with the blade of a scalpel held at right angles to the surface of the plant, or by prying slightly upward, instead of shaving horizontally. When the scales are thus removed, a box having a cavity 0.25×1×2 inches will hold a large number of diaspine scale insects. When host plant material is included, the boxes may be increased in over-all size up to 1.5×5×8 inches or more, as required. The cavity of the box may be partitioned to prevent too much shifting of the material in transit.

During the past year, the shipments of beneficial insects in water pine root boxes enclosed in cloth bags within a manila envelope have been highly successful as measured by the number of species introduced and propagated. Three of these are the parasitic Hymenoptera *Asipdiotiphagus* sp., *Aphytis* sp. and *Casca* sp. which, in China, apparently are of value in controlling the red scale, *Aonidiella aurautii*.

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[2] Entomologist in the Experiment Station.
[3] *Glyptostrobus pensilis*, which is a member of the Redwood family, grows only on the sandy shores of southeast China. The trees are common in the vicinity of Canton, but the wood is not very readily obtainable since the trees are semi-sacred and are planted for geomantic purposes.

A Laboratory Method for Evaluating DDT Residues

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The prolonged residual toxicity of DDT and other synthetic organic insecticides to insects has presented the problem of how to evaluate properly the effectiveness of these residues. A number of methods have been developed for this purpose and are now in use. The laboratory method described here was used in evaluating the effect of sunlight on DDT residues from various formulations that had been sprayed on glass plates (Chisholm *et al.*, 1949).

Adult house flies, *Musca domestica* L., were used as test insects. The flies were reared by the current method used with the Campbell turntable tests (Campbell & Sullivan 1938). This method, as now used, deviates from the published procedure in that Peet-Grady larval medium (Anon. 1948) is used and the migratory prepupal-stage larvae are driven out of the medium by wetting down with water. With this method approximately 100 flies emerge in a screened petri dish 20 mm. deep and 140 mm. in diameter. The flies were fed as described by Campbell & Sullivan until they were 2 to 3 days old, when they were used for testing.

In preparation for the tests the petri dishes were held in an electric refrigerator for about 10 minutes at a temperature of about 35° F. to immobilize the insects. All the immobilized flies from one large dish were then transferred to a petri dish 17 mm. deep and 90 mm. in diameter. The small dish was then inverted on a clean 5- by 7-inch glass plate, with cellophane strips 0.3 mm. thick under the edge of the dish. An ordinary desk lamp was then used to warm the flies. When all the flies had recovered from the chilling, the cellophane strips were used to pull the dish onto another glass plate the surface of which was covered with the residue to be evaluated. The cellophane strips prevented contact of the dish with the residue to be tested. Therefore, the crystalline structure was not disturbed.

The plate with the petri dish in place, was then set in a cubical screened cage similar to those described by Campbell & Sullivan (1934). A stop watch was used in timing exposures. At the end of the predetermined exposure period, the flies were liberated in the screened cage by lifting the petri dish and flushing all flies from the plate. The petri dish and glass plate were removed from the cage, food was provided, and the flies were held for 24 hours, when mortality counts were made. The food, a 2 to 1 mixture of skim milk and water, was soaked into a ball of cotton about 2 inches in diameter, which was then put into a clean petri dish.

Although 5- by 7-inch glass plates were used in these tests, larger glass plates or wooden or metal panels could be used. The plates or panels should be made up in sufficient replications so that an area once exposed to the flies is not reused.

The initial deposit of DDT on the glass plates was about 3 mg. per square foot. The residue on many of the plates had deteriorated due to various causes, and in nearly all the tests exposures of 2, 4, and 8 minutes gave less than 100 per cent mortality of flies. The exposure time to be used in a given study would, of course, vary with the kind and concentration of the deposit being studied and would have to be determned by preliminary testing.

With this method of evaluation the relative toxicities of the residues of various formulations as well as exposure time-mortality curves can be obtained. Checks can be included by subjecting the flies to identical procedure except for the use of clean, untreated plates or panels.

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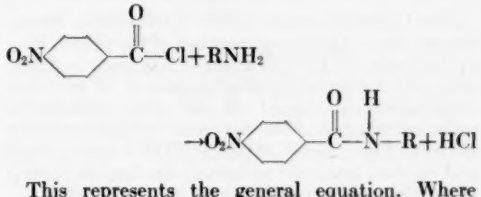
Laboratory Tests of Some Aliphatic N-Substituted *p-Nitrobenzamides* Against the Codling Moth

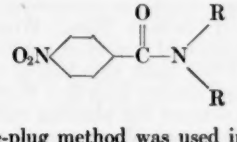
E. H. SIEGLER and S. I. GERTLER, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*

A previous paper by Siegler & Gertler (1948) reported the results of tests on a number of aliphatic N-substituted *m*-nitrobenzamides against newly hatched larvae of the codling moth, *Carpocapsa pomonella* (L.). The present paper presents the data obtained with some aliphatic N-substituted *p*-nitrobenzamides against this insect. Data for DDT and lead arsenate are included for comparison.

N-substituted *p*-nitrobenzamides were prepared by reacting *p*-nitrobenzoyl chloride with various primary amines under suitable conditions, according to the following equation:



This represents the general equation. Where secondary amines were used, the resulting compound is represented by—



The apple-plug method was used in all toxicity tests. A single ready-to-hatch codling moth egg was enclosed with each plug. From 90 to 107 plugs were used for tests of the benzamides, and 100 for tests of DDT and lead arsenate, and for each untreated

Table 1.—Toxicity to codling moth larvae of some aliphatic N-substituted p-nitrobenzamides as compared with DDT and lead arsenate.

Compound	Formula	Percentage of Apple Plugs	
		Wormy	Stung
N,N-Diisopropyl-*p*-nitrobenzamide	$C_6H_4NO_2CON[CH(CH_3)_2]_2$	61	11
N,N-Dipropyl-*p*-nitrobenzamide	$C_6H_4NO_2CON(C_3H_7)_2$	62	8
N-Isopropyl-*p*-nitrobenzamide	$C_6H_4NO_2CONHCH(CH_3)_2$	79	15
N-Propyl-*p*-nitrobenzamide	$C_6H_4NO_2CONHC_3H_7$	80	6
N-Butyl-*p*-nitrobenzamide	$C_6H_4NO_2CONHC_4H_9$	82	3
N,N-Dimethyl-*p*-nitrobenzamide	$C_6H_4NO_2CON(CH_3)_2$	88	0
N-Methyl-*p*-nitrobenzamide	$C_6H_4NO_2CONHCH_3$	88	1
N,N-Diethyl-*p*-nitrobenzamide	$C_6H_4NO_2CON(C_2H_5)_2$	90	2
N-Ethyl-*p*-nitrobenzamide	$C_6H_4NO_2CONHC_2H_5$	90	3
DDT (technical)		6	9
Lead arsenate		71	1
Untreated Check (Avg. of 2 tests)		96	0

check. The carrier for all tests consisted of water 80 per cent and ethanol (95 per cent) 20 per cent. All benzamides and lead arsenate were used at the rate of 4 pounds, and DDT was used at the rate of ¾ pound to 100 gallons of the carrier.

As shown in table 1, none of the benzamides indicated promise when compared with DDT. However, two of the benzamides, N,N-diisopropyl-p-nitrobenzamide and N,N-dipropyl-p-nitrobenzamide, were slightly more effective than lead arsenate under the conditions of the tests.

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Chlorinated Camphene, Chlordan, DDT and Calcium Arsenate Compared for Control of the Colorado Potato Beetle

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The Colorado potato beetle *Leptinotarsa decemlineata* (Say) takes an annual toll of the potato crop in Manitoba. In 1948 an attempt was made to determine the comparative effectiveness of 50 per cent chlorinated camphene,[1] 40 per cent emulsifiable technical chlordan,[2] 50 per cent wettable powder chlordan,[2] micronized 50 per cent DDT concentrate[3] and calcium arsenate[3] as insecticides for the control of the Colorado potato beetle.

Method.—Six plots, including a check, formed the experimental unit which was replicated at random 4 times, making an experimental area of 24 plots on the University Farm, Winnipeg. Each plot, which contained 5 rows of potatoes, 12.5 feet long, spaced 3 feet apart with hills every 15 inches in each row was planted with Red Warba potatoes. Wet weather delayed the planting and the potato plants did not appear above ground until around the end of June.

[1] Canadian Industries Ltd. (*Lozite*)
[2] Dow Chemical Co.
[3] Green Cross Insecticides.

The chlorinated camphene, the emulsifiable technical chlordan, the wettable powder chlordan and the micronized DDT were each used at the rate of one-half pound of pure chemical to 40 imperial gallons of water. The calcium arsenate was used at the rate of one and one-half pounds to 40 imperial gallons of water. Each insecticide was applied as a spray at the rate of one gallon to the 4 randomized plots allocated for each treatment. This is at the rate of approximately 58 imperial gallons of spray per acre. (Equal to about 69.5 U. S. gallons.)

The first application of the sprays was made on July 13. Adult Colorado potato beetles and small larvae, less than a week old, were present on the potato foliage at that time, The infestation was heavy and well distributed throughout the experimental area. A second and final application of the respective sprays was made on the afternoon of August 6. The sprays were applied with a 2.5 gallon compressed air sprayer fitted with a pressure gage. The initial pressure was at 30 pounds, but this pressure was reduced to approximately 15 pounds as the single gallon of spray required for the test was used.

Due to the presence of virus diseases all of the plots were rogued to remove all affected plants. Observations were made from time to time on the apparent effectiveness of the different insecticides and on the appearance of the potato foliage which had been sprayed with the various insecticides.

Discussion.—One day after the first sprays were applied it was estimated that the various plots carried on an average the following numbers of larvae: checks 750; calcium arsenate 110; 50 per cent wettable powder chlordan 15; 40 per cent emulsifiable technical chlordan 9; micronized DDT 9 and chlorinated camphene 2 larvae. Relatively few adults were present on any of the sprayed plots. On August 6, some of the plots were so badly reinfested with larvae that it was necessary to make a second application of the respective sprays. On August 7 all sprayed plots except those sprayed with the calcium arsenate were practically free of larvae. The larvae which developed on the check plots had become adults around the beginning of the second week of August. These adults had dispersed to all of the plots before the Middle of August. None of these adults were observed in copula at any time. Furthermore, none of the adult females which were dissected contained any eggs. Our observations seemed to

indicate that the potato foliage sprayed with the chlorinated camphene 50 per cent was slightly the greenest foliage.

POTATO YIELDS.—The potatoes from the middle three rows of each plot were harvested on September 14. As some diseased plants had been removed from these rows in each plot, the calculated yield per acre was based on the actual number of plants present in these three rows as compared with the possible number of plants per acre when spaced as indicated previously. The production from the four replicates in each case is the basis for the calculations shown in Table 1. All potatoes smaller than approximately 1.75 inches in diameter were culled out before weights were taken.

Table 1.—Potato yields per acre when sprayed with the insecticides listed below.

INSECTICIDE	BUSHELS PER ACRE	STANDARD ERROR
Chlorinated Camphene 50 per cent	320.8	33.9
Chlordan 50 per cent wettable powder	317.2	33.4
DDT concentrate 50 per cent, micronized	314.7	10.4
Chlordan 40 per cent, emulsifiable technical	278.8	13.7
Calcium arsenate	224.9	13.6
Checks	83.7	13.9

An analysis of variance indicated that the mean yields differed significantly. The F value is 17 and the 1 per cent point is 4.25.

COOKING TESTS.—Cooking tests were made by two families independently, of potatoes from each of the sprayed plots. In no case was any foreign or objectionable flavor detected in potatoes which were eaten as boiled potatoes.

SUMMARY.—1. None of the insecticides which were used appeared to injure the potato foliage.

2. Potato foliage sprayed with chlorinated camphene appeared to be slightly greener than the foliage on any other plot.

3. The highest tuber yields were obtained from the plots treated with 50 per cent chlorinated camphene, Chlordan 50 per cent wettable powder and micronized 50 per cent DDT concentrate, decreasing in the order named but there were no significant differences among these yields. Apparently any one of these insecticides as indicated by one year's work may be used on potato foliage with practically equal effectiveness for the control of the Colorado potato beetle.

4. Emulsifiable technical chlordan 40 per cent was not as effective as the former three insecticides.

5. Calcium arsenate which has been used widely for many years, gave much poorer control than any of the former four chemicals.

6. None of these insecticides impaired the flavor of potatoes grown on these plots when they were tested as boiled potatoes.[1]

[1] *Acknowledgments.* The writer is indebted to the Division of Plant Science, The University of Manitoba, for facilities for carrying out this investigation and to Mr. Orville Olsen of that Division in particular for his interest and assistance in planting and in servicing the experimental area throughout the summer. Thanks are also due to Dr. A. J. Thorsteinson, Department of Entomology for the statistical analysis which was made of the more detailed data and to Mr. G. L. Warren, student assistant in Entomology.

Parathion in Early Spring Applications for Bud Moth Control[1]

J. G. CONKLIN[2] and G. L. WALKER[3]

For the past several years the eye-spotted budmoth, *Spilonota ocellana* Schiff., has been on the increase in New Hampshire apple orchards. During the 1947 season damage was extensive in several commercial orchards, and in certain blocks as much as 75 per cent of the fruit showed injury at time of harvest.

In the spring of 1948, arrangements were made to conduct field tests with parathion in comparison with other commonly used insecticides as a possible means of control of the budmoth.

Prior to starting field tests, apple branches bearing overwintering budmoth larvae were brought in to the laboratory and forced under greenhouse conditions until the buds had partly opened and larval activity was first observed. Groups of branches were then sprayed with parathion (15 per cent wettable powder) at dosages of 2 and 4 pounds per 100 gallons of water, using a standard paint gun nozzle operated at 22 pounds pressure.

In two such preliminary experiments complete kill of budmoth larvae, including those still in their hibernacula, was obtained. In a third experiment the fruit buds were allowed to develop to the pink stage before sprays were applied, thus allowing ample time for all the larvae to have emerged from their hibernacula and to have begun feeding. In this instance, also, perfect control of the larvae was achieved.

Field experiments, based on the results of preliminary tests, were conducted at Wilton, New Hampshire. Large, heavily infested Baldwin trees were selected, and approximately 10 gallons of spray were applied per tree, using conventional spray equipment. Two single gun nozzles were operated, one from a tower mounted on top of the spray tank and the other from a low platform attached to the rear of the tank.

Experiment 1. In this experiment sprays were applied on April 7, when the trees were in the delayed-dormant stage of development. Counts are based on the examination of 50 buds selected at random from each of 10 trees scattered in the experimental block. The results are shown in table 1.

Table 1.—Styles Block.

MATERIALS USED	AMOUNT PER 100 GALS.	BUDS EXAMINED	BUDS INJURED	PER CENT INJURED
Parathion (15% wettable)	2 lbs.	500	32	6.4
Dinitro cresol	2 lbs.	500	197	39.4

Experiment 2. In this experiment sprays were applied on April 12, in a block of trees somewhat further advanced in bud development, but with larvae still in their hibernacula. The results of this experiment are shown in table 2.

[1] Scientific Contribution No. 122 of the New Hampshire Agricultural Experiment Station.
[2] New Hampshire Agricultural Experiment Station.
[3] Through the cooperation of General Chemical Division, Allied Chemical and Dye Corporation.

Table 2. Hartshorn Block.

Materials Used Per 100 Gallons	Amount Per 100 Gals.	Buds Examined	Buds Injured	Per Cent Injured
Parathion (15% wettable)	2 lbs.	1000	45	4.5
Nicotine sulphate	1 qt.			
Oil	2 gals.	1000	275	27.5

Experiment 3. In this experiment sprays were applied on May 4, when the trees were in the pre-pink stage and most of the larvae had left their hibernacula and were feeding on the buds. At this time many of the larvae were completely hidden within the buds where they would be expected to be more difficult to reach with the insecticide. Counts were made 6 days following treatment, and only those buds showing budmoth injury were examined. The results are shown in table 3.

Table 3. Results from pre-pink sprays.

Materials Used Per 100 Gallons	Amount Per 100 Gals.	Buds Examined	Dead Larvae	Per Cent Dead
Parathion (25% wettable)	1.2 lbs.			
Wettable sulfur	7.5 lbs.	250	242	96.8
Nicotine sulphate	1.5 pints			
Lead arsenate	3.0 lbs.			
Wettable sulfur	7.5 lbs.	250	87	34.8

On June 8 the orchard was again examined for evidence of budmoth injury, The trees which had received the parathion treatment were free of new budmoth injury, whereas trees which had received the nicotine-lead arsenate treatment showed severe foliage injury and numerous active budmoth larvae.

Discussion. Laboratory and field tests indicate strongly that parathion in early spray applications will control the eye-spotted budmoth under New Hampshire conditions. Complete clean-up of heavily infested trees was obtained with a single application of parathion (25 per cent wettable powder) used at the rate of 1.2 pounds per 100 gallons of water. The pre-pink stage of bud development would appear to be nearly ideal from the standpoint of spray-timing.

Rye Jointworm Doing Damage in Nebraska

C. A. Sooter and Martin H. Muma

In the summer of 1946 moderate to heavy rye lodging was noted on a farm near Atkinson in Holt county, Nebraska. Farmers reported serious local losses and were becoming much concerned On August 13 of that year a general survey of the infested Holt county area was made and 6 samples of 50 culms each were collected. Four of these samples were infested with from 6 to 36 per cent of the culms having galls of the rye jointworm, *Harmolita secalis* (Fitch), an average of 0.5 gall per culm. There was an average culm infestation of 15 per cent for all samples (23 per cent infestation average for the infested samples). From this survey and county agent reports the infestation appeared to be localized in the vicinity of Emmet, Atkinson and Stuart in northwest Holt county.

On June 25 and 26, 1947, another survey of the infested area was made. At that time 13 samples were collected in Holt county, two in Rock county, two in Pierce county, one in Antelope county east of Royal and one in Brown county just west of Long Pine. Infestations were found in the vicinity of Atkinson, Emmet and O'Neill in Holt county and 5 miles west of Bassett in Rock county. From the data obtained yet is evident that jointworm is a serious problem in the area immediately north and west of Atkinson. An average of 23.5 per cent infestation was found in all samples from that area. The lightest infestation was 14 per cent while the heaviest showed 56 per cent of the culms with live jointworms in galls. There was an average of 3.32 jointworm galls per infestee culm in the Atkinson area; and an over-all infestation average of .78 of a gall per sulm in all of the samples collected.

It is expected that farmers in the infested area will continue to experience general losses unless the practice of continuous rye cropping on the same or adjoining land is changed. Soil and moisture conservation practices do not permit control by burning or plowing the straw under because it is needed on the surface to keep the sandy soil from blowing very badly.

Specimens collected from the Atkinson area on November 8, 1947 were reared at Lincoln where they emerged April 26, 1948. These were identified by Mr. A. B. Gahan of the Bureau of Entomology and Plant Quarantine as the rye jointworm, *Harmolita secalis* (Fitch).

This infestation was deemed noteworthy in view of the fact that a general review of the literature revealed few records of damage by this jointworm

The Toxicity of DDT Deposits as Influenced by Sunlight

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Several studies have been made of the stability of DDT under different conditions. A review of some of these studies has been presented by Cristol and Haller (1945). Chisholm & Koblitsky (1947) reported on the effect of light on DDT residues as measured by chemical analysis. Langford & Squires (1947) found that the residues on leaves from water suspensions were much more potent and lasting than those from emulsions. This paper presents the results of a preliminary study made to evaluate the effect of sunlight on the toxicity of residues from various water suspensions and emulsions of DDT that had been sprayed on glass plates.

The sprays used are given in table 1. The standard water suspension was selected to represent a DDT formulation commonly used. The two types of hydrated lime, sulfur, Bancroft clay, and bordeaux mixture are often included in agricultural sprays. Limonite was considered to be representative of iron impurities sometimes found in sprays or on sprayed surfaces. The solvents used in the emulsions represented the various types used in DDT sprays. The

[1] The authors are indebted to J. E. Fahey for valuable suggestions and for furnishing several of the materials used in this investigation and to L. Koblitsky for chemical analyses.

aluminum powder, titanium dioxide, carbon black, and diethylaniline were added to spray 10 to test the possibility of influencing the residual action of emulsion sprays by adding agents to reflect and absorb sunlight. The first two materials reflect sunlight and the other two absorb it.

Table 1.—Mean per cent mortality of flies exposed to deposits of DDT suspensions and emulsions that had been subjected to no sunlight and to 32 and 64 hours of sunlight.

Spray No.	Formulation (Quantities per 100 Gal.)	No Sunlight	32 Hours	64 Hours
	Suspensions			
1	Standard (DDT-pyrophyllite (50:50) 2 lb. emulsifier[1] 4 oz.)	48.8	41.8	33.8
	Standard plus 1 lb. of—			
2	High-calcium hydrate limed	49.0	.5	.8
3	High-magnesium hydrated lime	56.2	.5	0
4	Sulfur (micronized)	42.5	24.2	18.2
5	A dust conditioner (200-mesh)[4]	38.2	23.8	9.8
6	Clay[5]	50.2	23.5	1.8
7	Standard plus bordeaux mixture 4-4-50	20.5	7.0	.2
	Emulsions			
	DDT 1 lb. plus emulsifier[1] 4 oz. plus solvent to make 1 gal.:			
8	Methylnaphthalene[2]	12.2	0	.2
9	White mineral oil[3] (80:20 by vol.)	26.2	4.2	6.5
10	Kerosene-xylene (80:20 by vol.)	8.5	8.2	1.2
11	Xylene	1.0	0	0
	Spray No. 10 plus 1 lb. of—			
12	Aluminum powder	.5	2.0	0
13	Carbon black	55.0	2.0	.5
14	Diethylaniline	2.0	.2	.2
15	Titanium dioxide	21.2	2.0	0

[1] A mixture of polyoxyalkylene derivatives of sorbitan tetralaurate and -oleate.
[2] *Velsicol AR-60* chiefly mono- and di-methyl naphthalenes.
[3] *Marcol-xylene* white mineral oil U.S.P. Saybolt viscosity at 100° F. 80–90 sec.
[4] *Limonite.*
[5] *Bancroft clay.*

For each test six 5- by 7-inch glass plates were placed horizontally at equal intervals close to the perimeter of a circular turntable that rotated about 4 r.p.m. A fine-mist spray was directed over the plates so that each plate passed through the spray twice. A uniform deposit of approximately 3 mg. of DDT per square foot was obtained without run off. After all the plates were dried, diametrically opposite plates were paired. One pair was stored in the dark. The remaining pairs were exposed out of doors in uncovered trays. The exposures were made only on bright days in July and August 1947, between 10 a.m. and 4 p.m. At other times the plates were kept in the dark indoors. After an accumulated exposure period of 32 hours, one pair was removed to storage. The other pair was stored after 64 hours. Untreated check plates, in duplicate, were included with each set of six treated plates.

Biological tests of the toxicities of the residues were made at intervals between October and February, according to the method described by Nelson (1949). Adult house flies, *Musca domestica* L., were used as test insects. They were exposed to the suspension residues for periods of 2 and 4 minutes, and to the emulsion residues for 4 and 8 minutes. The increased exposures on the emulsion residues were necessary to get measurable kills. Each plate was tested at both exposures. With the plates in duplicate, it was possible to make four tests at each sunlight exposure. The untreated check plates in each set were tested in the same manner. The freshly sprayed plates were not biologically evaluated.

The fly-mortality data for the four tests on each residue at each exposure were combined, and the mean mortality was calculated. These data are also presented in table 1. Occasionally one or two flies on the untreated plates died, but such mortality was regarded as negligible.

It is probable that at least some of the results shown in table 1 may have been influenced by the storage period of several months that intervened between spraying and testing, and by the difference between the fly-exposure periods for the emulsion deposits and those for the suspension deposits.

The toxicity of the emulsion deposits was markedly less than that of the suspension deposits, even when the plates were stored in the absence of sunlight. Since the original deposits of DDT were approximately equal, it appears that most of the emulsion residues deteriorated more rapidly in storage than the suspension deposits. The best emulsion was that containing carbon black (spray 13). The results with the suspension containing bordeaux mixture (spray 7) showed that this combination had a deleterious effect on DDT even when the deposit was not exposed to direct sunlight.

All the deposits, with the possible exception of the standard (spray 1), were less toxic after exposure to sunlight. All the suspension deposits, except those containing the hydrated lime and bordeaux misture (sprays 2, 3, and 7), were much more resistant to decomposition by sunlight than were any of the emulsion deposits. The toxicities of these three deposits and of all the emulsion deposits were reduced to a very low level even after as little as 32 hours of exposure. Mortalities of 2 per cent or less indicate little or no toxicity as tested here. Carbon black (spray 13) did not provide measurable protection from sunlight decomposition. Clay (spray 6) appeared to accelerate decomposition, as is indicated by the low level of toxicity after 64 hours of exposure as compared with that of the standard.

These preliminary results indicate that the toxicity of DDT deposits may be reduced by exposure to sunlight or during storage. Also, under the conditions of these tests, deposits from suspensions were more toxic than those from emulsions, and maintained a higher level of toxicity after exposure to sunlight. These results also suggest the importance of the type and the composition of DDT formulations to be used in connection with insect-control programs. A more critical study of some of these variables is in progress.

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Field Experiments with Hexaethyl Tetraphosphate for Cabbage Aphid Control[1]

T. E. BRONSON and P. V. STONE[2] *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine,* and T. C. ALLEN, *Wisconsin Agricultural Experiment Station*

Laboratory tests of hexaethyl tetraphosphate dusts and sprays have indicated that this material is highly toxic to the cabbage aphid, *Brevicoryne brassicae* (L.) (Bronson & Hall 1946). Very satisfactory results were obtained with a dust containing 3 per cent of this material and with a finely atomized aqueous spray containing 2 per cent, when they were used immediately after being mixed. Roark (1947) reviewed the literature on hexaethyl tetraphosphate.

During 1946 field experiments were conducted at Kenosha, Wis., with hexaethyl tetraphosphate[3] as compared with nicotine, for the control of the cabbage aphid on cabbage. The materials were applied both as dusts and as sprays, and in one experiment hexaethyl tetraphosphate was used as an aerosol.

Dusts containing 3 per cent of hexaethyl tetraphosphate in pyrophyllite and 5 per cent in talc were tested. They were prepared by placing the diluent in a rotary cement mixer, together with a number of smooth stones, and spraying onto it the proper quantity of undiluted chemical while the mixer was rotated. The aerosol contained 5 per cent of hexaethyl tetraphosphate, 5 per cent of a mixture of di- and tri-methylnaphthalenes, 40 per cent of trichloroethylene, and 50 per cent of methyl chloride. The hexaethyl tetraphosphate sprays were perpared from a commercial preparation containing 50 per cent of hexaethyl tetraphosphate with an emulsifier. The finished sprays contained 1 part of this preparation to 400 or 800 of water, or 0.12 or 0.06 per cent of hexaethyl tetraphosphate.

A 3-per cent nicotine dust was prepared by mixing hydrated lime with a proprietary dust containing 10 per cent of nicotine alkaloid in ground tobacco stems. A nicotine sulfate spray was prepared by adding 1 quart of nicotine sulfate (40 per cent nicotine) and 5 ounces of a phthalic glyceryl alkyl resin to 100 gallons of water (1:400). The finished spray contained the equivalent of 0.1 per cent of nicotine.

All the hexaethyl tetraphosphate preparations were applied soon after being mixed, since they deteriorate rapidly. All dusts were applied at the rate of 35 pounds per acre with a tractor-mounted power duster without an apron or hood, and the sprays at 100 gallons per acre under 300 pounds pressure, with a sprayer operated by a power take-off from a tractor. The aerosol was applied at the rate of 16 pounds per acre by means of a 12-foot broadcast-type boom consisting of 12 oil-burner nozzles connected by quarter-inch copper tubing. Each nozzle was capable of delivering 2 gallons per hour, and these nozzles released the aerosol within an enclosed hood to which a muslin apron 10 feet long was attached.

Three experiments were conducted, each consisting of four insecticide treatments and an untreated check replicated four times in randomized blocks. All plots contained four rows 300 to 400 feet long.

Hexaethyl tetraphosphate, like nicotine, is quick acting. Therefore, infestation records were taken 24 hours after treatment. In order that the test plants might have populations reasonably high and as nearly uniform as possible, 75 consecutive cabbage plants were selected in an inside row of each four-row plot, and from these plants the most heavily infested plant of each successive group of three was chosen. The infested leaf area on each plant was estimated and the total infected area for the 25 plants was used as the measure of infestation.

RESULTS—Results of these experiments, summarized in table 1, indicate that all the hexaethyl tetraphosphate treatment were superior to the nicotine treatments. In the first experiment the hexaethyl tetraphosphate was more effective as a dust than as a spray or aerosol, but the dosage as a dust was about twice that as a spray and slightly higher than that as an aerosol.

Table 1.—Results of hexaethyl tetraphosphate treatments against cabbage aphids infesting cabbage.

TREATMENT	INFESTED LEAF AREA ON 100 PLANTS	LOG OF INFESTED LEAF AREA[1]	CONTROL
	Square inches		*Per cent*
Experiment 1			
Hexaethyl tetraphosphate:			
Dust 3%	25	2.854	98
Aerosol 5%	55[2]	4.768	96
Spray 1:1600	183	5.525	86
Nicotine sulfate spray 1:400	291	7.143	77
Check (no treatment)	1,269	9 875	—
Difference required for significance (odds 19:1)	—	1.995	—
Experiment 2			
Hexaethyl tetraphosphate:			
Dust 3%	50	3.813	92
Spray 1:800	6	.516	99
Nicotine alkaloid dust 3%	151	5.973	76
Nicotine sulfate spray 1:400	137	5.878	78
Check (no treatment)	636	8.304	—
Difference required for significance (odds 19:1)	—	1.434	—
Experiment 3			
Hexaethyl tetraphosphate:			
Dust 5%	8	1.034	99.7
Spray 1:800	17	2.365	99.5
Nicotine alkaloid dust 3%	409	7.032	87
Nicotine sulfate spray 1:400	1.821	10,424	41
Check (no treatment)	3,105	11,553	—
Difference required for significance (odds 19:1)	—	1.775	—

[1] These values are the sums of the logarithms of the infested leaf areas for the 4 replicates. Analysis was through the courtesy of the University of Wisconsin.
[2] Based on only 3 replicates.

In the second experiment the strength of the hexaethyl tetraphosphate spray was adjusted so that approximately the same dosage was applied as in the dust—about 1 pound of hexaethyl tetraphosphate per acre. In this experiment the spray was definitely superior to the dust. Nicotine gave some control but was much less effective than hexaethyl tetraphosphate. None of the plants sprayed with hexaethyl tetraphosphate had more than a half square inch of infested leaf area.

In the third experiment about 75 per cent more hexaethyl tetraphosphate was applied as a dust than as a spray. Both preparations were very effective, especially in protected areas of the plant where it is difficult to obtain good coverage. In this

[1] Authorized for publication by the director of the Wisconsin Agricultural Experiment Station.
[2] Now entomologist with the Wisconsin Alumni Research Foundation.
[3] Hexaethyl tetraphosphate is now known to be a mixture containing tetraethyl pyrophosphate as the principal active ingredient.

experiment the nicotine dust gave fair control and the nicotine spray very poor control, perhaps because of the slightly higher concentration of nicotine in the dust. The check plots were heavily infested. None of the plants dusted with hexaethyl tetraphosphate had more than a half square inch of infested leaf area.

DISCUSSION.—These data and field observations show that the cabbage aphid can be controlled with a 5-per cent hexaethyl tetraphosphate dust or a spray mixture containing 1 part of hexaethyl tetraphosphate to 800 parts of water. Further investigation is necessary, however, before it can be recommended for this purpose.

After repeated use it was found that the porcelain lining of the pump cylinders was rather badly etched, undoubtedly by the hexaethyl tetraphosphate. This rough surface wore the pump leathers rapidly, and it was necessary to replace them after every 2 to 3 hours of operation. Some aerosol nozzles became clogged, perhaps by residues resulting from chemical action of the hexaethyl tetraphosphate on the tanks or fittings.

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Effect of Soil Fertilization on the Rate of Reproduction of the Two-Spotted Spider Mite

PHILIP GARMAN and B. H. KENNEDY

It has been known for a long time that mite populations respond in some way to food supply derived from the leaves on which they feed. European red mites, for example, frequently decline after bronzing the foliage sometimes independently of natural enemy abundance. Whitcomb (1943) concluded that greenhouse red spiders infesting roses were less abundant on leaves with high pH sap, and it is well known that selenium introduced into some plant tissues has a direct influence on red spider abundance. Similarly, the citrus mite was thought by Thompson (1939) to be increased by nutritional sprays of copper and Halloway *et al.* (1942) observed a similar phenomenon from sprays of copper, zinc and manganese sulfate. The latter attributed the increase to "some physical or chemical property of the spray rather than the quantity of inert material used." It is possible that these sprays may have changed the pH among other things.

Thus, from the facts that internal plant poisons retard mite development, that exhaustion of food retards development regardless of predators and that spays of copper, zinc and manganese presumably *increase* the rate of reproduction it would seem that the nutritive value of the cell sap had much to do with the density of mite infestations. From this evidence, as well as from the observation that pH of the leaves affects abundance on roses, it would appear almost a certainty that some internal plant condition must be partly responsible at any rate for the rise or fall of mite populations. Studies do in fact show that fluctuations occur under field conditions independent of weather or predators (although both are of considerable importance) thereby indicating additional factors, probably connected with palatability to the mites or ability of the leaf contents to support increase.

Table 1. Effect of fertilization on reproduction of two-spotted spider mites on beans. Population at the end of 2 and 3 weeks starting from one adult female. Soil cultures.

DATES 1948	POTS FERTILIZED 7-5-9 No. TESTS		POTS UNFERTILIZED No. TESTS	
	3-Week Tests			
Apr. 27–May 18	5	86.2	4	34.5
May 14–June 4	5	62.2	8	0.0
May 26–June 16	2	88.6	2	12.0
	Average	79.0		23.2
	2-Week Tests			
Apr. 27–May 11	4	28.0	3	16.6
Apr. 29–May 13	10	44.7	5	34.6
May 5–May 19	9	32.8	7	15.4
June 1–June 15	3	40.0	5	38.3
	Average	36.4		26.2

If the theory, then, is correct, plants in poor growing condition would harbor fewer mites than those in good vigor. In support of this we find that unsprayed, unfertilized trees frequently have fewer mites than those that have been sprayed and fertilized. In the past, however, this phenomenon has been attributed more to the action of predators, so the idea of verifying our hypothesis became of immediate interest.

METHODS. Single adult females were placed in cells made by gluing felt on microscope slides after cutting a hole in the felt. To confine the mites, a similar plain slide was clipped on the back of the leaf with pressure enough to keep individuals confined on the leaf within the cell. The females were taken from a single leaf, or from colonies appearing to be of the

Table 2.—Effect of fertilization on reproduction of two-spotted spider mites. Population at end of experiment starting from one adult female.

DATES	No. TESTS	FERTILIZER	Fertilized	No. Tests	Unfertilized
		Sand Cultures—Beans			
Sept. 27–Oct. 18	11	Formula 1[1]	129.09	2	14.50
Sept. 22–Oct. 6	9	Formula 2[2]	31.55	12	16.08
Sept. 28–Oct. 13	6	Formula 2	11.92	7	8.00
		Peaches in Sand			
Sept. 15–Oct. 5	5	Formula 3[3]	103.4	5	53.4
Sept. 23 Oct. 7	8		126.6	5	96.2

[1] Ra-Pid-Grow—Specially repared water soluble fertilizer containing Nitrogen 23%, Phosphoric Acid 21%, Potash 17%, plus other elements, also Vitamin B_1 and B_2. 1 teaspoon per quart—100 ml. per plant.

[2] Magnesium Sulfate 98.6 gm.—2 liters water
Calcium Nitrate 236.2 gm.—2 liters water
Potassium Acid Phosphate 13.6 gm.—1 liter water
Potassium Nitrate 101.10 gm.—2 liters water
145 cc each solution to 1443 ml. water used three times weekly as 100 ml. per 4 inch pot.

[3] Magnesium sulfate 259. gm. } dissolved together
Calcium nitrate 469. }
Calcium phosphate 42.3 }
Potassium nitrate 48. }
Ferric Chloride 1.875 gm. } diasolved together
Boric acid .125 }
Copper sulfate .125 }
Potassium permanganate .190 }
Both solutions added to 20 gals.—1 gal. per 3-gallon crock.

same age. No counts were made until after the first week, but the totals were again taken after 2 weeks and in some cases 3 weeks. All stages were counted. Open barriers preventing the movement of mites from leaf to leaf were tried but were unsuccessful. Our first tests were with bean plants grown in potted soil and fertilized heavily with 7-5-9 mixture. It soon became evident that soil variations were responsible for considerable variation in results and sand cultures were substituted. Here there was an even greater difference between fertilized and unfertilized in relation to populations developing. All plants were kept in a greenhouse under average growing conditions.

RESULTS.—In the first series of soil tests (3 weeks, table 1) nearly three times as many mites developed on the fertilized plants as on the unfertilized; in the second series after 2 weeks there was a 27 per cent increase over the unfertilized. In the sand cultures, table 2, there was also a great difference after 3 weeks and a considerable one after 2 weeks. Peaches grown in sand reacted similarly to the beans, table 2, showing that either plant will produce heavier populations of mites if heavily fertilized In all these tests natural enemies were of course not a factor being excluded by the cell barrier.

CONCLUSIONS.—In view of the evidence presented here as well as records of a confirmatory nature in the literature, it is concluded that mite populations may easily fluctuate with the variable vigor of the host plant, due to heavy or light fertilization.

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A Second Record of *Lipoptena mazamae* from Cattle

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Texas deer, *Odocoileus virginanus* (Boddaert), are commonly parasitized by the Hippoboscid, *Lipoptenae mazamae* Rondani. Dr. J. C. Bequaert (1942) lists this fly from Angelina, Bexar, Colorado and Kerr Counties in Texas. Personnel of the State Department of Health have taken this species in Aransas, Blanco, Comal, Gillespie, Kendall and Lavaca Counties. Since deer and cattle frequent the same areas the possibility has not been overlooked that the fly might also parasitize the cattle. However, only one Texas record of this deer parasite from cattle has come to the writer's attention. July 4, 1947, several specimens of Hippoboscidae taken from a cow in Comal County, Texas, were sent to the Division of Entomology, Texas A. & M. College, College Station, Texas. They were identified as *L. mazamae* by Dr. J. C. Bequaert. The only known record in literature of this parasite from cattle has been made by Dr. Bequaert (1942) in Chatham County, Georgia.

Even though this parasitic deer fly transfers its attention to cattle on a large scale, it is not likely to become a serious ectoparasite where the cattle are dipped or sprayed with one of the new organic insecticides. The ease with which this Hippoboscid can be controlled with DDT has been recently demonstrated at the Aransas Federal Game Refuge. Deer trapped there by the Texas Fish, Game and Cyster Commission unner a federal permit are moved to other Texas counties, other states and even occasionally to territories outside the United States. In an effort to prevent the spread of ectoparasites of concern in the transmission of human and animal diseases from the heavily infested Gulf Coast region, it was decided to spray the deer before they were moved from the game refuge. Excellent results were obtained in controlling *Lipoptena mazamae* by treating the animals with 1 or 2 per cent wettable DDT (one pint per animal). Twenty-six deer were sprayed in initial tests.—12/2/48

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Toxicity to House Flies of DDT and Two DDT Analogs

R. H. NELSON, W.A. GERSDORFF, and S. I. GERTLER, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine*

Numerous analogs of DDT are known and a few are in use as insecticides. Metcalf (1948) has recently published the results of studies on the insecticidal efficiency of certain of the fluorine analogs and has included a review of pertinent literature.

Dichlorodiphenyltrichloroethane, or DDT, is more accurately described chemically as 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane. The studies reported here were made to determine the relative toxicities to house flies, *Musca domestica* L., of DDT and of two analogs in which the chlorine atoms in the para position on the aromatic rings were replaced by atoms of another halogen. These two compounds were the fluorine analog, 1,1,1-trichloro-2,2-bis(*p*-fluorophenyl)ethane, and the bromine analog, 1,1,1-trichloro-2, 2-bis(*p*-bromophenyl)ethane. It should be emphasized that there was no change in the aliphatic component of the molecule, this being the trichloroethyl group in all three compounds. Chemically pure materials were prepared for use in these tests. For convenience the materials are referred to in this paper as DDT, bromine analog, and fluorine analog.

The bromine analog had a melting point of 144° C. and a molecular weight of 443.4. For the fluorine analog the corresponding figures were 45° and 321.6, and for DDT 108° and 354.5.

The comparisons in this study are based on measurements of toxicity to house flies as determined by the Campbell turntable method. The flies were reared by standard procedure. Preliminary tests were made to determine the concentrations on a weight-volume basis of each of the materials required to cause mortalities at several levels. Solutions were made up in deodorized kerosene. The usual standard, the mixture of pyrethrins obtained

Table 1.—Toxicity to adult house flies of DDT and its bromine and fluorine analogs when applied in kerosene sprays.

MATERIAL	CONCENTRATION	MEAN KNOCK-DOWN IN 25 MINUTES	MEAN MORTALITY IN 1 DAY	MEAN CONCENTRATION CAUSING 50 PER CENT MORTALITY	RELATIVE TOXICITY AT 50 PER CENT MORTALITY LEVEL
	Mg./ml.	*Per cent*	*Per cent*	*Mg./ml.*	
DDT	0.667	40	92	0.24	1
	0.444	35	84		
	0.222	24	45		
Bromine analog	1.00	34	91	0.45	0.53
	0.667	29	72		
	0.444	18	49		
Fluorine analog	1.50	44	82	0.82	0.29
	1.00	40	56		
	0.667	26	39		
Pyrethrins (standard)	3.66	100	73	2.04	0.12
	1.83	100	39		
	0.92	100	23		

from the kerosene extract of pyrethrum flowers, was included in the tests for comparison.

Approximately 100 flies were used per test, and 8 replications were run at each concentration, knock-down and mortality percentages being determined. The results are given in table 1. The concentrations causing 50 per cent mortality were obtained by plotting the mean mortalities on log-probability paper and reading the values from the lines fitted by the method of least squares.

It is clear from the tabulated data that, under the conditions of these tests, the bromine and fluorine analogs as space sprays are not so toxic as DDT to house flies. The relationship is shown by the tabulated figures calculated for the relative toxicity at the 50 per cent mortality level. Busvine (1946) obtained median lethal concentrations against body lice, *Pediculus humanus corporis* Deg., and bed bugs, *Cimex lectularius* L., with the same three compounds. Our data on the relative toxicity to house flies are in the same order and of similar ratio to those Busvine obtained on body lice and bed bugs. In Peet-Grady tests against house flies Prill *et al.* (1946) found the fluorine analog to be less active and the bromine analog about equal to DDT. Metcalf (1948), however, found the fluorine analog to be about equal to DDT in initial toxicity to most of the 12 species of insects he studied, but more rapid in action. Rapidity of action, as measured by knock-down in our tests, shows DDT to be the faster acting against house flies.

As a matter of interest, the mean concentrations causing 50 per cent mortality as shown in table 1 were calculated to molar solutions, and the relative toxicity was calculated on this basis. The molar concentration and the relative toxicity for the three materials were as follows: DDT 0.00068 and 1; bromine analog 0.0010 and 0.68; fluorine analogy 0.0026 and 0.27. These figures agree very well with those obtained with the weight-volume concentration figures and indicate that on a molecule-to-molecule basis the order of toxicity to house flies of the three compounds is about as shown in table 1.

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Further Notes on the Host Relationships of Ticks on Long Island[1]

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An earlier paper[2] by the same authors gives an account of the ticks found on 16 species of mammals and 26 species of birds collected on Long Island in 1946 and 1947. The mammals included 293 specimens and the birds 74 specimens, with a total of 2824 ticks of all stages. These included seven species, namely: *Dermacentor variabilis* (Say); *Haemaphysalis leporis palustris* Packard; *Ixodes cookei* Packard; *I. dentatus* Newmann; *I. marxi* Banks; *I. muris* Bishopp and Smith; and *I. scapularis* (Say).

One phase of the work included serological studies of the animals collected, carried on by and under the direction of, Dr. J. K. Miller.[3] Sera and tissues from foxes and raccoons proved to be best suited for these studies. Furthermore, these two animals and skunks carried greater numbers of *Dermacentor*

[1] Presented at the 20th annual meeting of the Eastern Branch of the American Association of Economic Entomologists, New York City, Nov. 19, 1948.

[2] JOUR. ECON. ENT. Feb. 1949.

[3] Associate Director, Division of Laboratories and Research of the State Department of Health.

variabilis, the principal local vector of Rocky Mountain spotted fever. Therefore, in 1948, the studies were confined largely to fox, raccoon, and skunk, and the present paper is concerned chiefly with the additional information gained from these more restricted studies.

The 81 animals taken in 1948 included 45 red foxes, 12 raccoons, 3 eastern skunks, 2 eastern cottontails, 2 meadow mice and 17 muskrats. The same seven species of ticks found in 1946 and 1947 were found in 1948, distributed as follows: *Dermacentor variabilis* on red fox, raccoon, skunk, microtus and rabbit; *Haemaphysalis leporis-palustris* on rabbit; *Ixodes cookei* on red fox, raccoon and skunk; *I. dentatus* on rabbit; *I. marxi* on raccoon; *I. muris* on red fox, rabbit and skunk; and *I. scapularis* on red fox and skunk. No ticks of any species were found on muskrat.

Table 1 shows seasonal abundance of ticks on the hosts from March to August. From the 81 animals, 1226 ticks of all stages were collected. *Dermacentor variabilis* was the predominant tick on each animal species except the eastern cottontail, on which *Ixodes dentatus*, *I. muris* and *Haemaphysalis leporis-palustris* were more numerous. In 1946 and 1947 *I. muris* was predominant on most of the animals and occurred in greater numbers than *D. variabilis*. In 1948, the greatly increased number of foxes taken resulted in the predominance of *D. variabilis* in the collections. The eastern skunk had the highest total average of *D. variabilis* per host (40.6), but this may have been due to the fact that the skunks were fewer in number and were all captured at the peak of the tick season while the foxes were taken before, during and after this peak.

Table 1.—Abundance of ticks on hosts, 1948. (All hosts and all stages of ticks included.)

Month	No. Animals	No. Ticks	Av. No. Ticks Per Host
March	24	36	15
April	6	97	16.1
May	14	523	37.3
June	22	403	18.3
July	12	147	12.2
August	3	20	6.6
Totals	81	1226	15.1

The total average of *Dermacentor variabilis* per fox was 18.5. Table 2 shows the distribution of adult *D. variabilis* on red fox from March through August It may be noted that the average number of *D. variabilis* per fox rises rather sharply in May, (35.8), and then declines gradually. This indication that the peak abundance of *D. variabilis* occurred during the months of May and June was reflected also in the dragging records which were highest during these two months.

The only adult ticks of any species found on the red fox in 1947 were *Dermacentor variabilis*. In 1948, adult specimens of *Ixodes scapularis* and *I. cookei* were also found.

Of the total of 1226 ticks taken in 1948, only 7 were larvae, 70 were nymphs and the remaining 1149 were adults. Thus, 93 per cent of the ticks collected in 1948 were adults, and 88 per cent of all adults taken were *Dermacentor variabilis;* 10 per cent were *Ixodes scapularis*, and the remaining 2 per cent were *I. cookei*, *I. marxi*, and *Haemaphysalis leporis-palustris*.

Table 2.—Abundance of adult *Dermacentor variabilis* on fox, 1948.

Month	No. Animals	No. Ticks	Av. No. Ticks Per Host
March	6	1	0.1
April	5	34	6.8
May	9	323	35.8
June	15	344	23.0
July	7	113	16.1
August	3	17	5.6
Total	45	832	18.5

The immature stages were distributed as follows: the 45 red foxes had 50 immature ticks, of which *Ixodes muris* was the predominant species; 12 raccoons had seven immature *I. cookei;* three skunks had four immature *I. muris* and one *I. cookei;* two meadow mice had seven *Dermacentor variabilis* nymphs and two rabbits had six immature *I. muris* and two immature *D. variabilis*.

Only one specimen of *Ixodes marxi* was collected. This was a partly engorged female taken from a raccoon captured west of the Shinnecock Canal. In 1947 the 37 specimens of *I. marxi* also came from west of the canal.

Ixodes scapularis was found on red fox in 1948, but not in 1946 or 1947. *I. marxi* and *I. cookei* were both found on raccoon in 1948, but not in 1946 or 1947. *I. cookei* was also found on skunk in 1948, but not in 1946 or 1947.

Whether or not these figures indicate a seasonal or geographic fluctuation in abundance, or perhaps some variations in host preference, has not been determined. Only further work can shed light on this question. At least it is evident from these records as well as from the other data that collections over several years are required to give the complete pattern of host relationship.

The largest number of ticks found on any one animal was taken from a red fox collected on June 2 from Shelter Island. On the same fox were 218 adult *Dermacentor variabilis*, three females and one nymph of *Ixodes scapularis* and one nymph and one larva of *I. cookei*.

All foxes collected during May and June had ticks, but *Dermacentor variabilis* was more abundant on animals collected east of the Shinnecock Canal. The 7 foxes collected east of the canal during May and June had 421 adult *D. variabilis* or an average of 60 per fox, while the 17 foxes collected west of the canal during the same period had 246 *D. variabilis* adults or an average of 14.5 per fox.

The next most abundant tick was *Ixodes scapularis*. It is interesting to note that this species also was more common east of the Shinnecock Canal. The total number of *I. scapularis* adults on the 20 foxes taken east of the canal was 114, whereas the total on the 25 foxes taken west of the canal was only three. The period of highest incidence of adults on the hosts was April, as compared with late May and early June for *Dermacentor variabilis*.

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An Editorial Faux Pas—or Worse

SHORTLY after the appearance of the December number of the JOURNAL the editor received news of an inexplicable blunder. The editorial in that issue was credited to Dr. S. A. Rohwer when, as a matter of fact, it was contributed by Professor J. J. Davis. Inasmuch as both these gentlemen have been well known to the editor throughout our mutual entomological lives and the editor well knew that only Professor Davis could have written the editorial, the blunder was made. At first there was no possible explanation; later, the editor decided what must have happened and how he permitted himself to let the blunder happen. But the explanations are not in order; the fact remains that it was essentially carelessness and entirely inexcusable, even though now explainable.

The mistake did great injustice to both gentlemen concerned. This injustice can not be corrected. Since editorial material is usually largely matters of opinion and point of view, the crediting of editorial statements to the wrong man is much more serious than if the mistake affected matters of fact only.

The readers of the JOURNAL are asked to indicate in their copies that the editorial, signed S. A. Rohwer, should bear the name of J. J. Davis and, if they have criticisms of the editorial, to direct them to the person responsible and absolve Dr. Rohwer of the blame. Conversely, bouquets should be addressed to Professor Davis.

When the opportunity presents itself, the editor will publicly eat whatever dish of crow either of the aggrieved gentlemen may set before hm. When all is said and done, it is true that the fire caused by a carelessly dropped cigarette may cause just as much damage as the one maliciously set by an incendiary and the regret of the careless culprit can not repair the damage.

Finally, the editor extends his most sincere apologies to the two gentlemen concerned and to the Association. If anything could increase his regret at the incident it would be to lose, in any degree, the friendship of either of them.

L. M. PEAIRS

A New Departure

IF it may be said that a custom which was once established and later abandoned can, after a time, become once more new, the JOURNAL is presenting a new departure in the form of a news section. This will not be completely organized in the current issue but will take form to a greater extent in the April number of the JOURNAL.

The Associate Editor, Mr. Harry B. Weiss, will conduct this section. It is hoped that news items affecting entomologists, especially personal notes, may be sent to Mr. Weiss by all who may have knowledge of them. As the number of entomologists increases and concurrently, the numer of our personal as well as professional friends increases, it becomes increasingly difficult to keep track of them. News notes which will facilitate this are most welcome. Then entomological events also are increasing. Regional meetings, not only the larger ones of the Sections of the Association and of other permanent organizations, but informal groups with common problems which are not necessarily permanent, get together with increasing frequency. Notes of such meetings should be sent in. If each reader will remember that items which interest him will doubtless interest many others, and will send accounts of such events, it will be easy for Mr. Weiss to arrange the most interesting section of the JOURNAL.

Some notes will be used as fillers at the bottom of short pages but it is hoped that the items of greatest general interest, such as personals, may be arranged in a compact section.

Address all notes to Mr. Harry B. Weiss, 616 First-Mechanics National Bank, Trenton, New Jersey.

OBITUARIES

EDWARD GUERRANT KELLY

Edward Guerrant Kelly, 1880-1949

Edward Guerrant Kelly was born at Concord, Kentucky, July 25, 1880. He died February 7, 1949, at Manhattan, Kansas. He received his bachelor's and master's degrees from the University of Kentucky, and Doctor of Philosophy degree from Iowa State College. Doctor Kelly was a member of the staff of the Department of Entomology, University of Illinois from 1904 to 1907. In 1907, he was appointed as a research entomologist to the Federal Bureau of Entomology and placed in charge of the Research Station at Wellington, Kansas. He did splendid research work in developing control methods for Hessian fly, wheat strawworm, greenbug, chinch bug and cutworms attacking wheat. He directed the work of several assistant entomologists and continued research work until 1918, at which time he was employed by the Kansas State College as Extension Entomologist, which position he held until his death. His excellent annual reports, which were prepared and handed in on time, are not surpassed by those of any extension entomologist. During his thirty years as Extension Entomologist in Kansas he served on several national committees, organized and successfully conducted state-wide campaigns for the control of Hessian fly, grasshoppers, chinch bugs, army cutworms, wheat strawworms, wheat white grubs attacking staple crops and cattle grubs, lice, blood sucking flies, and screw-

worm flies attacking livestock. Professor L. C. Williams, Dean of the Extension Division, Kansas State College in eulogizing Doctor Kelly as an extension entomologist states," So successful was he in getting the findings of our research and experiment staff to farmers that his insect control programs were accepted in a comparative short time. His thirty years of work is a good example of what an agricultural extension worker can do. His contribution should be an inspiration."

Doctor Kelly held membership in many honorary societies and professional organizations: Gamma Sigma Delta, honorary agricultural fraternity; Sigma Xi, science fraternity; the American Association of Economic Entomologists, The American Association for the Advancement of Science; The Kansas Academy of Science and the Kansas Entomological Society. He also was a member of the First Christian Church of Manhattan, a thirty-second Degree Mason and a Shriner.

Doctor Kelly was an excellent organizer and took hold of an insect control campaign with the intention of doing it well and it was always done well. He was trustworthy and dependable. During the forty years of his work in Kansas, thirty of which were as extension entomologist, he was always willing to carry more than his share of work. He possessed the rare ability of quickly analyzing a situation, particularly an insect outbreak, and he seldom erred in his judgment. Doctor Kelly's work with the girls and boys in the 4-H Clubs was also constructive and well worthwhile. I personally attended several of his schools and was surprised at the interest the boys and girls took in making insect collections; they were interested in mounting and naming the insects in the insect boxes. They also were interested in the life history of the insects and the methods of control.

His fine generosity and vision of professional service were largely instrumental in determining the practice of free interchange of insect control. The loss of his fellowship, experience and resourcefulness is incalculable.

GEO. A. DEAN

George Ware Barber, 1890-1948

George Ware Barber (1890–1948), American naturalist, educator and writer, and member of the American Association of Economic Entomologists since 1914, died in his fifty-ninth year in New York City, December 5, 1948.

Descendent of an old New England family, he was born at Hyde Park, Massachusetts, August 3, 1890. He early manifested an interest in natural history and every phase of outdoor life, and particularly in entomology and ornithology.

He was graduated B.Sc. from the (then) Massachusetts Agricultural College in 1913, and M.S. and Sc.D. from Harvard in 1925 and 1927 respectively.

He entered service of the U. S. Department of Agriculture, in the (then) Bureau of Entomology on January 1, 1914, and worked thereafter on wireworms in Missouri, on range caterpillar in New Mexico, and on Hessian fly in Kansas and Maryland. During World War I, he was on furlough from the Department as Lieutenant of Cavalry in the U. S. Army, November 25, 1917 to May 19, 1919. On its termination and his return to the Bureau, his assignments included investigations of the European corn borer in New England and Ohio and the corn earworm in various Eastern states from New England to Georgia until his retirement from Government service at age 55 on November 15, 1945, though he continued thereafter as Bureau collaborator without pay.

Although Dr. Barber performed much work of permanent value along the various indicated lines of investigation during his long employment in the Bureau doubtless his most outstanding single achievement and that of greatest practical usefulness was the discovery and development of oil-insecticide treatments of sweet corn for earworm control. In 1936 his tests showed that a little highly refined white mineral oil injected into the silk at the tips of corn ears would protect them against earworm injury. Until his discovery was made, no satisfactory treatment for the protection of corn ears from damage by this insect was known. By 1939 Dr. Barber had improved the efficiency of this oil treatment by adding a very small percentage of pyrethrins, without producing an undesirable flavor or residue. He also developed a practical method of applying the treatment profitably not only to small plantings of sweet corn by home growers but also to commercial plantings of sweet corn and seed corn by means of hand-force oilers or by atomization onto the silks. By 1942, Dr. Barber had demonstrated that a very small percentage of dichloroethyl ether or styrene dibromide could be substituted for war-scarce pyrethrins. Following his discoveries extensive and profitable use has been made of the oil-insecticide method by sweet corn growers in Florida, New Jersey, Texas, California, Idaho and other States. He received a meritorious promotion in recognition of this accomplishment and was cited for it by the U. S. Department of Agriculture in its Research Achievement Sheet No. 16-E, January 8, 1945.

Shortly after his retirement from Government service, he entered upon special investigations of the behavior of the house fly and toxicity of new insecticides notably DDT under the auspices of Rutgers University located at New Brunswick, New Jersey, in which capacity he served until his death. His work at Rutgers University amply demonstrated his unusual qualities as teacher and as scientist. He had a profound influence on his associates and especially on the graduate students in entomology. His broad knowledge and experience, coupled with his success in aiding students and in winning their confidence, his jovial nature and insatiable capacity for work were a continuous source of wonder and admiration to his associates.

During his years of Bureau and other work he was author or joint-author of 91 publications on entomological and related subjects. Even a cursory survey of these reveals abundant evidence of the high character and thoroughness of his work, his close and thoughtful observation, and the wide range of his interests.

In addition to his published work, the files of the Division of Cereal and Forage Insect Investigations in Washington, with which he was connected, contain several reams of reports, not intended for publication, that record in minute detail and extensive tabulations the scope, progress and results of his investigations on the European corn borer and on corn earworm, every part arranged in meticulous

GEORGE WARE BARBER

order and all covered by comprehensive indexes also prepared by himself.

His versatility and breadth of interest are well illustrated by his large and varied collections of specimens and literature, and several unfinished manuscripts dealing with such widely varied subjects as "Studies in the ecology of the Passerine birds of the Richmond, Virginia area," and "Contributions to the history of early medical entomology as found in the writings of Dr. David Livingstone."

During Dr. Barber's various entomological assignments, he always took every opportunity to make collections of noteworthy or worthwhile adult and larval material wherever found. In course of time his insect collection expanded to several hundred Schmitt boxes of pinned specimens and many thousands of specimens in alcohol, most of which was taxonomically classified and arranged, and all accompanied by full notes. He spent many hours of labor thereon and in care of light traps often until late at night, following long days of field work.

From boyhood he was a passionate lover of books, and with the passing of years he gradually formed a large and increasingly valuable library of several thousand volumes, this being particularly strong in natural science and general literature. The scientific portion comprised not only an unusually large working collection of the type of books and pamphlets ordinarily found on the work table of an average investigator, but it also contained numerous rare taxonomic classics and many complete sets of scientific periodicals as well. General literature too was represented, in addition to the usual items of general interest, by many beautifully bound illustrated standard sets in Classical, English and American literature.

In addition to his interest in science, Dr. Barber

also was an accomplished musician, could perform creditably on several instruments, and, when favorable location enabled him to do so, was actively identified with various local musical activities. Sensitive to the touch of beauty he was a lifelong student and observer of flowering plants. An enthusiastic philatelist, he likewise accumulated a large and valuable stamp collection, having particular emphasis on the more artistic forms.

On July 28, 1919. Dr. Barber married Miss Estelle Hulse of Chattanooga, Tennessee, who, with their only child, George Winston, survive him. For the past several years Dr. Barber and family have made their home at 20 Edgewood Avenue, New Haven, Connecticut.

In addition to the American Association of Economic Entomologists, his membership or fellowship included the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the Entomological Society of America, the New York Entomological Society, the Ecological Society of America, the Agriculture History Society, and the American Ornithologist's Union.

Although deeply interested in ornithology, it was not always possible for him to take time from more pressing entomological work for more than noncontinuous field observations as opportunity offered in various western and southwestern States, as well as in Virginia, Georgia and Florida, therefore, his notes are of necessity somewhat fragmentary. His library, however, was particularly rich in the more important and more valuable contributions in ornithological literature.

On the whole, Dr. Barber's life was an exceptionally useful one. His native bent for observation of nature developed into an enthusiasm that was profoundly stimulating to his professional associates. Possessing much personal charm and an individuality which enhanced interest both in his letters and informal conversation, he had a most enviable gift for making and keeping friends, and there are many of them to mourn his passing. Economic entomology, in the death of Dr. Barber, has sustained a very definite and very genuine loss.

J. S. WADE

Andrew Olof Larson, 1887-1948

Andrew O. Larson, Associate Entomologist (Retired), U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, died Nov. 2, 1948. He was born at Molen, Utah, Sept. 11, 1887, and married Sophronia Peterson, who survives him, on Dec. 23, 1908. Also surviving are six children, Andrew Warren Larson, Mrs. Firona L. Johnson, Noel P. Larson, Mrs. Sarma L. Williams, Mrs. Chloe L. Cook, and James C. Larson, as well as a number of grandchildren. Two sons, Andrew and Noel, are members of the American Association of Economic Entomologists.

After completing the normal course at the University of Utah in 1912, Mr. Larson received his B.S. degree from the Utah State Agricultural College in 1916, and his M.S. degree from the University of Southern California in 1924.

After a short period teaching school, Mr. Larson entered the field of entomology with the Utah Agricultural Experiment Station, working on the control of pests attacking alfalfa. He was appointed as a special Field Assistant in the Bureau of Entomology, U. S. Department of Agriculture, in 1918, for work in California as a part of a national survey to determine the distribution of the newly introduced Oriental fruit moth. Upon the completion of this assignment, Mr. Larson was assigned to a laboratory which had just been established in 1919 at Alhambra, Calif., for work on weevils affecting beans. Later this laboratory was transferred to Modesto, California. With the initiation, in 1930, of an investigation on the pea weevil, Mr. Larson was placed in charge of the work at Corvallis, Oregon. In 1936 he was assigned to Twin Falls, Idaho, for work on the beet leafhopper.

ANDREW OLOF LARSON

Mr. Larson's failing health enforced his retirement in 1939, thus ending a career in entomology which was marked by his interest and painstaking effort to further the work in his chosen field.

The author of more than 40 scientific articles, Mr. Larson published the results of his work on weevils in detail in two Technical Bulletins of the Department, No. 593 "The Bean Weevil and the Southern Cowpea Weevil in California" and No. 599 "Biology and Control of the Pea Weevil in the Pacific Northwest."

Despite his impaired health, Mr. Larson continued his work in the Church of the Latter-Day Saints after his retirement, serving five years as the first Bishop of the Alhambra Ward.

Mr. Larson was a member of the American Association of Economic Entomologists, the Entomological Society of America, the Washington Entomological Society, and a charter member of the Entomological Club of southern California.

ROY E. CAMPBELL AND
T. A. BRINDLEY

Theodore Dru Allison Cockerell
1866-1948

"We are too apt to receive the gifts of Science without asking whence they come. It is well therefore, to learn something of the lives of those who have made discoveries or organized scientific work." This admonition, written in 1919 by Professor Cockerell, well serves to introduce a review of some of his own experiences and accomplishments as one of America's most outstanding biologists. For almost

THEODORE DRU ALLISON COCKERELL

three quarters of a century there emanated from his keen mind and fluent pen—in prose and in poetry—an ever-growing concatenation of observations about insects, snails, fish, flowers, organic evolution, sociology, and the philosophy of life itself. In his death, on January 26, 1948, the scientific world lost not only an internationally recognized authority on bees, scale insects, fossil invertebrates and plants, but a sage and kindly teacher and a painstaking investigator of many biological phenomena.

Theodore Cockerell was born in Norwood, England, August 22, 1866. Following the death of his father, the family moved to Margate, by the sea, and here a panorama of marine and littoral life was revealed to him which undoubtedly stimulated and directed his early interests in natural history. While still in his "teens" he commenced collecting snails and contributing articles concerning them to scientific periodicals. He was soon recognized in conchological circles and continued to write about this group of invertebrates until the aggregate of his publications exceeded two hundred articles. During this same period of early life he made his first entomological contribution—a description of the larva of the Madeiran butterfly—*Pyrameis indica occidentalis*—which was recognized in Lang's book on European butterflies.

Cockerell received his early education in private schools in England, and he attended Middlesex Hospital Medical School from 1883 until 1886. He did not receive a degree, but was apparently forced to withdraw because of ill health and move to a more healthful climate. He chose Colorado and in 1887 we find him at West Cliff, near Boulder, living an outdoor life, collecting insects, and communicating some of his observations by letter to Dr. C. V. Riley, then editor of *Insect Life*. After remaining here for several years he returned to England and worked in the British Museum in 1890 and 1891. There he became acquainted with a number of British naturalists, among them Alfred Russell Wallace, and he experienced the unique privilege of assisting Wallace in the revision of his views on Darwinism, published under the title *Island Life*.

In 1891, Cockerell was appointed Curator of the Public Museum at Kingston, Jamaica, where it was among his duties to "conduct investigations in economic entomology and answer all correspondence of this kind." This was his first official assignment in the field of applied entomology and he edited a series of styleographic sheets covering his observations and distributed them among the "planters." While in Jamaica he became interested in scale insects and mealy bugs because, as he later wrote, "they were excessively abundant . . . of economic importance" and "the literature at that time was not very extensive and it was possible to remember more or less clearly the characteristics of all of the known species." For more than two decades he retained an active interest in this group and described well over a hundred species, including such economic examples as the cottony cochineal scale, the cottony cactus scale, the red date scale, the fruit tree *Pulvinaria* and the pineapple mealy bug.

In 1893 a recurrence of the illness of which he thought himself cured necessitated another change of climate, and through the influence of his friend C. H. Tyler Townsend, he secured an appointment as Professor of Zoology and Physiology in the New Mexico State College of Agriculture at Mesilla Park. Here he remained for almost seven years serving on both the teaching and Experiment Station staffs, being associated as friend and co-worker with a number of men who later became prominent through their contributions to southwestern agriculture. Among these, in particular, were Fabian Garcia, a student of Horticulture and Director of the Experiment Station from 1913 to 1945; Hiram Hadley, first President of the College, later Vice-President of the University of New Mexico at Albuquerque and from 1905 until 1907 Superintenednt of Public Instruction for the Territory; W. O. Wooten, geologist, botanist and co-author of Wooten & Standley *Flora of New Mexico* and J. D. Tinsley, soil physicist and biologist for the Experiment Station, who later served for many years as General Agricultural Agent for the Santa Fe Railway.

The majority of Cockerell's scientific contributions during this period were in the field of economic

entomology and ecology and included titles such as *Scale Insects of New Mexico, Life Zones of New Mexico,* and *Preliminary Notes on the Codling Moth.*

While in New Mexico, he developed a second taxonomic interest, that of wild bees, which proved to be even more lasting and fruitful than his earlier one in scale insects. For the remainder of his entire life, Cockerell pursued his investigations of this group, first describing those species which he collected in New Mexico and Colorado and gradually extending these researches to include the fauna of almost the entire world. By 1938, he had published the names and descriptions of 5,480 species of lesser categories and 146 names for genera and subgenera. He traveled widely, collected them in foreign lands, visited and studied collections in the larger museums, and, as a recognized authority, received large collections from practically every portion of the globe. Within a short time of his death, he was still engaged in studying collections of bees from Honduras and monographing certain genera.

Cockerell's life in New Mexico was saddened by the loss of his first wife, Annie Sara Fenn, an English, woman of "considerable literary promise," and of a son, who was born to them in 1893 and died of diphtheria when only seven years of age.

In 1900, Cockerell moved from State College to Las Vegas, New Mexico where he taught in the Normal University for several years. Here he married Miss Wilmatte Porter, a woman with similar interests in biology and teaching, and it was she who shared and furthered his investigations and accomplishments for the remainder of his life. Probably their most important joint contribution was in the field of genetics of sunflowers and the development of orange and red varieties.

In 1903 Cockerell returned to Colorado and served successively as curator of the Colorado College Museum and lecturer in entomology at the University of Colorado. He also held the position of consulting entomologist for the University of Arizona between 1901 and 1909 and in this capacity investigated the scale insects of date palm in the Salt River Valley. He found that two species were economically important, *i.e.* the date palm scale, *Parlatoria blanchardi* (*Targ*), and the red date scale, *Phoenicococcus marlatti* Ckll. and published these findings in Arizona Bulletin 56 in 1907.

In 1906 he was advanced to full professorship at the University of Colorado and was awarded the honorary degree of Doctor of Science in 1913. From then until retirement in 1934 he divided his time between teaching and research, with frequent expeditions to foreign countries or other parts of the United States. A large portion of his research time was devoted to the taxonomy of bees, snails, fossil insects, and plants. By the time he had reached retirement, the aggregate of his publications exceeded 1200 articles. His teaching was characterized by a thoroughness and enthusiasm which inspired many of his students to become teachers and self-reliant research workers. His two books *Zoology* and *Zoology of Colorado* are still useful as introductory texts to southwestern zoology.

Although given the title Professor Emeritus in 1934, Cockerell did not retire from active work. He continued the pursuit of his favorite research interests, traveled widely, collecting and lecturing on biological subjects, and frequently taught for short periods at educational institutions where he was made welcome through the generous extension of their respective facilities. He spent a number of winters in Southern California investigating the ecology of a number of islands off the coast and later in Honduras in Central America where he taught economic entomology in the Pan American Agricultural School at Tegucigalpa and the private school of Harold Brosious near Minas de Oro.

At various times during his life he was a member of or served in an official capacity in a large number of scientific societies. Among these were the American Association for the Advancement of Science, the Entomological Society of America, the American Association of Economic Entomologists, and the American Philosophical Society.

So great were Cockerell's accomplishments during a life span of 81 years, and then often in spite of physical handicaps, that it is only natural to seek an explanation. This may be found not only in his extraordinary intelligence and devotion to science but likewise in a philosophy of life which gave him mental calm and conviction of purpose. This latter characteristic, expressed frequently in his writings, is well illustrated by two quotations, a portion of a poem, written soon after his settling in Colorado, and a sentence in prose written a few years before his death:

"Our course is run, our harvest garnered in,
And taking stock of what we have, we note how life,
This strange, mysterious life which now we hold
and now eludes our grasp,
Is governed still by natural law, and its events
Tread on each other's heels, each one compelled
to follow where the first has led.
Noting all this, and judging by the past,
We form our plans, until we know at last
The treasure in the future's lap—
Bold climber, all that thou hast won
Lies still in shadow of the peaks above:
Yet in the morning hour the sun
Rewards thy work of love,
Resting a moment on thy lesser height,
Piercing the vault with rays too bright to face,
Strengthens thy soul and gives thee ample might
To serve thy human race."

"The scientific man is always on the road, never at the journey's end."

—JOHN R. EYER

BOOK REVIEWS

THE BLOWFLIES OF NORTH AMERICA, by David G. Hall. Page 477, with 5 four-color process plates, 46 plates of black and white line-drawing engravings, and 9 text figures. Published by the Thomas Say Foundation of the Entomological Society of America. Printed by the Monumental Printing Com pany, Baltimore, Md., January, 1948. Price, $6.50. Obtainable from J. J. Davis, Purdue University, Lafayette, Indiana.

This is an important monographic treatment of the Calliphoridae. Blowflies have received much public and scientific attention within the past few years not only because of their importance as myiasis producing parasites of man and animals but also because of their possible role in the transmission of poliomyelitis. The apparance of "The Blowflies of North America" will be welcomed not only by entomologists, but by physicians, health officers, sanitary officials, veterinarians, and others in any way concerned with preventive medicine, entomology, or public health.

The book summarizes the biological information so far recorded about blowflies. It describes their various stages and discusses their economic importance. It contains sections on the history of these flies, and how to collect, preserve, and study them.

The section dealing with blowfly control gives the most modern methods of dealing with the pests, from the use of the insecitide EQ 62 for myiasis cases in livestock, to the utilization of 2-engined aircraft for the over-all reduction of such flies in great areas.

The blowflies of North America (family Calliphoridae) are grouped by the author into five subfamilies; these form chapter-headings in the book. All species of blowflies known to occur on the North American Continent, and the West Indies, are included. The fauna consists of 27 genera and 83 species, a number of which are described forthe first time.

A key to the major groupings of American muscoid flies enables one to determine whether a specimen is a blowfly or not, and to which subfamily of Calliphoridae it belongs.

The subfamilies, tribes, and genera are arranged hylogenetically. Under each subfamily, keys are given to genera and species. The species names are paginated in the key for easy reference purposes. The discussion of species, which are arranged alphabetically under the generic heading, includes the synonomy, description of each of the stages so far as known, distribution, biology, habits, and economic importance.

Unfortunately names for many of the common blowflies known for many years under certain names are now changed. No doubt the author conducted thorough research to establish the correct names now assigned to many of the species so that such changes will not be necessary in the future. The generic name *Callitroga* is now used instead of *Cochliomyia*, and *Apaulina* replaces *Procalliphora* the generic name formerly assigned to the North American bird nest screwworm flies. The use of *Phaenicia* for all but one of the species of greenbottle flies formerly called *Lucilia*, and the use of *Calliphora vicina* R. D. for the common bluebottle fly long-known as *Calliphora eurythrocephala* (Mg.), are among the other changes. The author explains in detail reasons for using the name *Callitroga americana* (C.&P.) rather than *C. hominivorax* (Coq.).

The volume is well bound in serviceable blue buckram with gold lettering. The paper is of excellent quality, the typography is distinctly above average.

Special attention must be called to the many excellent illustrations in this book. It is unfortunate that the line drawings could not have been reprodused as text figures and printed on the same pages with the specific descriptions, rather than being grouped together on plates at the back of the book where they are more difficult to use. The many excellent illustrations, which include line drawings of heads, wings, genitalia of males, and often females, and the principal structure of the larvae add greatly to the usefulness of the book.

It is unfortunate that the book could not have appeared in the early war years when it was first ready for the printers. It could have been of great service to our military efforts. However, this will not detract from its usefulness in the future.

E. F. KNIPLING

CHEMISTRY AND USES OF INSECTICIDES, by E. R. deOng. 1948. viii+353 p. $6.00. Reinhold Publishing Co., New York.

Under insecticides the author includes not only insect killers but fungicides, week killers, rodenticides, and other "economic poisons." The book is intended to give the public both the scientific studies on insecticides and the industrial development with its background of legal supervision. Chapter headings are: Introduction, which scans the making of insecticides from "backyard to chemical factory" as the many uses developed; arsenic and its compounds; copper and its compounds; sulfur and its compounds; miscellaneous inorganic compounds—fluorine, selenium, mercury, etc.; mineral and other oils; fumigants and fumigation; plant derivatives, synthetic organic compounds; and, heat, cold and radiation as insecticides. Each chapter has an extensive list of refernces which unfortunately have no apparent order, either alphabetical, chronological, or other. The dictionary of insecticides among the appendixes includes numerous compounds, not treated in the text, with simple definitions such as "seed disinfectant" or "insecticide, used for aphids." There are sections on legal requirements covering the manufacture and sale of insecticides and fungicides, and official antidotes. Treatment of the many different materials naturally vary in length with the accumulated knowledge and the value of each. The fuller treatments, such as for rotenone, include chemical characteristics, insecticidal action, use, formulation of dust and sprays, and compatibility. The book contains a wealth of information that will be useful to beginning students, advanced researchers in pest control, and to manufacturers.

THEODORE L. BISSELL, *College Park, Md.*

DICTIONARY OF GENETICS. Including Terms used in Cytology, Animal Breeding and Evolution. Compiled by R. L. Knight (Senior Economic Geneticist, Empire Cotton Growing Corporation and Sudan Government). Lotsya. A Biological Miscellany. Vol. 2. 183 pages. Waltham, Mass.: Chronica Botanica Co., New York City: Stechert-Hafner, Inc. Price $4.50.

This glossary of genetic and allied terms is based upon the terminology abstracted from about 150 selected books and articles which are listed in the

bibliography. Most of these are British although some 40 seem to be of North American origin. Included in the list are the more recent standard texts such as Hayes and Immer on plant breeding, Lush or Rice on animal breeding, Goldschmidt's "Physiological Genetics," Mayrand also J. Huxley on evolution, as well as many of the older sources—Darlington, Wilson on cytology, and older texts on genetics and allied subjects. In addition there are a number of shorter papers from the genetical and biological journals. The majority of the perhaps 2500 terms defined have to do with cytology, genetics, evolution, breeding, endocrinology and vitamins. Many terms pertaining to entomology, insect morphology, embryology, biometry, and reproduction in animals and in seed plants are also cited. There seems to be a general and complete omission of comparable terms for application to the reproduction, and hence genetics, of the fungi, and one looks in vain for elucidation of such words as "kappa" and "killer" in relation to the genetics of protozoans. Some words which might sacrcely be found outside of the original paper in which they were used—cleistogameon, luploidion, strathmokinesis for examples—will be found, together with a number of unusual terms—as cyesis, synacme—as substitute words for others in more common use. It is, of course, the definition of unusual and unknown terms that is of greatest use in a work of this sort. The definitions of terms are in general both well-considered and easily understandable. Both errors and omissions seem to be very few indeed. Akinete is defined as "a resting cell"; it might better have been limited to a type of spore in the algae. The word "sobole" is listed and defined as "a rhizome or underground creeping stem." This perhaps represents the latin singular noun "soboles," or more correctly "suboles," meaning a stolon, runner, or shoot, and with various derived meanings such as race and gens in the latin. Appendices give useful tables and formulae, the International Rules for symbolizing genes and chromosome aberrations, and distances recommended for the avoidance of pollen contamination in seed production in crop plants. Dr. Knight's Dictionary will be a useful addition to the book shelf of the student or investigator, whether geneticist, cytologist, breeder, or entomologist, who reads in the literature of genetics and allied subjects.

J. L. CARTLEDGE

CHEMISTRY AND USES OF INSECTICIDES. DeOng, E. R. viii+345 p. $6.00. Reinhold Publishing Co., New York. 1948.

Under insecticides the author includes not only insect killers but fungicides, weed killers, rodenticides, and other "economic poisons." The book is intended to give the public both the scientific studies on insecticides and the industrial development with its background of legal supervision. Chapter headings are: Introduction, which scans the making of insecticides from "backyard to chemical factory" as the many uses developed; arsenic and its compounds; copper and its compounds; sulfur and its compounds; miscellaneous inorganic compounds—fluorine, selenium, mercury, etc.; mineral and other oils; fumigants and fumigation; plant derivatives, synthetic organic compounds; and, heat, cold and radiation as insecticides. Each chapter has an extensive list of references which unfortunately have no apparent order, either alphabetical, chronological, or other. The dictionary of insecticides among the appendixes includes numerous compounds, not treated in the text, with simple definitions such as "seed disinfectant" or "insecticide, used for aphids." There are sections on legal requirements covering the manufacture and sale of insecticides and fungicides, and official antidotes. Treatment of the many different materials naturally vary in length with the accumulated knowledge and the value of each. The fuller treatments, such as for rotenone, include chemical characteristics, insecticidal action, use, formulation of dust and sprays, and compatibility. The book contains a wealth of information that will be useful to beginning students, advanced researchers in pest control, and to manufacturers.—T. L. BISSELL.

A CATALOGUE OF INSECTICIDES AND FUNGICIDES. Vol. II. Chemical Fungicides and Plant Insecticides. Donald E. H. Frear. X+153 pages' Annales Cryptogamici et Phytopathologici (incorporating Annales Bryologici). Vol. VIII. Frans Verdoorn, editor. Chronica Botanica Co., Waltham, Mass., and Stechert-Hafner, Inc., 1948. $5.50.

This volume includes 37 pages of coded references to synthetic organic compounds tested as fungicides, 33 pages listing plant species investigated as insecticides, and a list of literature references and patents covering 28 pages. The literature has been searched up to January, 1944.

As promised in Volume I (see review in J. Econ. Ent. 41(3):421, June, 1948), the present volume includes an alphabetical index of the nearly 10,000 chemical compounds treated in both volumes, arranged under the system of nomenclature used in Chemical Abstracts. This allows ready reference to the information on any given compound, without recourse to the ingenious coding system by which the compounds have been classified according to their chemical relationships.

These volumes are indispensable to the student, the teacher, and the research worker in the field of economic poisons. The author may take comfort in the knowledge that others will be spared many hours of the thorough, painstaking inquiry represented by this comprehensive compilation.

The publishers announce that a limited number of copies of the two volumes will be bound together in morocco, and interleaved with blank paper. These will be available shortly at $22.50.

H. N. WORTHLEY

FILTERABLE VIRUSES. By Francis O. Holmes, Rockefeller Institute for Medical Research, Princeton, N. J. 159+xxiii pages. 1948. Williams & Wilkins Co., Baltimore, Md. Price $2.50.

This book, a systematic treatment of the viruses, constitutes "an exact reprint, without change of paging or other details, of Supplement No. 2, *Bergey's Manual of Determinative Bacteriology*, 6th Edition, published in 1948, except the *Index* which is revised and enlarged." As such it serves as a small volume of handy size and of ready use to virologists without the encumbering size of the larger *Manual*. Except for isolated attempts, this work represents the first thorough and authentic effort to classify animal, plant, and bacterial viruses following a binomial system.

The order Virales, as presented by the author, consists of 13 families, 32 genera, and 248 species. Three large groups are recognized, namely viruses

affecting bacteria, viruses having only animal hosts, and viruses invading higher plants. Keys to the various families and genera are included, and each species is named, described, and accompanied by references to the pertinent literature. Unfortunately the long period of time the book was in press did not enable the author to bring the references as up-to-date as may be desired, although coverage up to 1943 is adequate.

As far as entomologists are concerned, the book is of value primarily as it presents information pertaining to the insect vectors of plant and animal virus. The viruses causing diseases in the insects themselves are also treated, but recent discoveries have reduced the informative value of this small section (family Borrelinaceae). The vectors of the plant and animal viruses are listed in excellent form, the specific and familial scientific names as well as the common names being given.

The format of the book and its printing are of excellent quality. Without question the book will be of great value not only to those interested in the systematics of viruses but to entomologists and others who are concerned with the insect transmission of both animal and plant viruses. Regardless of what one's personal philosophy may be concerning the advisability of attempting a classification of viruses at this time, a great deal of credit must be extended to Dr. Holmes for his courageous undertaking and for the vast amount of strenuous labor that went into the preparation of this volume. The author deserves the heartiest congratulations for his accomplishment!

EDWARD A. STEINHAUS.

LARVAE OF INSECTS—Part I *Lepidoptèra* and leaf feeding *Hymenoptera*. By Alvah Peterson, Ohio State University, Columbus, Ohio, Lithoprinted, cloth bound, 8″×10½″ 84 plates, 315 pages. Price $5.00.

This is the book for which many of us have been waiting. In the past most institutions have stressed the taxonomy of the mature stages of insects with very little emphasis on the immature stages. Many entomologists have realized the fallacy of such an arrangement as soon as they started working in the field and discovered that it is the immature stage of insects which cause most of the damage. Also, in the case of parasites and predators, it is usually the immature stage that does the most good. Consequently, it is the immature stage which is usually seen by the economic entomologist, the field man, the plant inspector, the county agent or the grower.

Many seem to "shy away" from a study of immature insects. The first glance at the keys in the present volume will probably cause additional concern until an honest attempt is made to use them. To some it may be somewhat of a new language but the "new" terms are well defined in the glossary which is included and there are many references to figures which illustrate the characters being used in the keys.

Once the 84 plates of drawings are examined it will be realized that Dr. Peterson has truly prepared a "picture book" of immature insects that can be used by anyone.

Part I presents detailed information on many common and important species of Lepidoptera and plant infesting Hymenoptera. The introductory portion discusses the various technics of collecting, killing, preserving, restoring and inflating larvae. It also contains keys to all the common orders for nymphs, larvae and pupae and many figures of each.

Under each order (Lepidoptera and Hymenoptera) are keys to families, some special keys to species and bibliographies. Probably the most valuable portions for each order are the descriptions of living larvae and the numerous plates of drawings, which show diagnostic characteristics of species. Larvae of each family also are described. Lists of family names, lists of scientific and common names of many species and lists of food plants for all species figured are included. Part I ends with a key to abbreviations, an extensive glossary and a general index. Part I is a good job, well done and written for the most part in the universal language of pictures.

It is to be hoped that Part II will be available in the near future.

Part I may be obtained from the author or Ward's Natural Science Establishment, Inc., 3000 E. Ridge Road, Rochester, N. Y.

CLYDE F. SMITH

GROWTH OF PLANTS—Twenty Years' Research at Boyce Thompson Institute. William Crocker. New York: Reinhold, 1948. Pp. v+459. (Illustrated.)

The research of the Boyce Thompson Institute since its founding in 1924, is presented in a coherent, scholarly, and interesting fashion that is characteristic of the scientific reports emanating from this Institution.

The broad title of many a book often indicates a coverage of subject matter which an inspection of the book reveals to be lacking. In this particular one, however, the main title, "Growth of Plants," is less indicative of the nature of the contents than the subtitle, "Twenty Years' Research at Boyce Thompson Institute." For the benefit of those who may not be fully acquainted with the scope of their research, the main fields of endeavor may be indicated by a listing of the various chapter headings. Dr. Crocker has ably reviewed the work on: Life Span of Seeds; Dormancy in Seeds; Physiological Effects of Ethylene and Other Unsaturated Carbon-Containing Gases; Effect of Certain Lethal Gases upon Plants and Animals; Dormancy in Buds; Plants Grown under Controlled Environmental Conditions; and, Miscellaneous Studies. In addition, certain chapters were contributed by co-authors, as follows: Plant Hormones (Dr. P. W. Zimmerman); Plant Cell Membranes (Mrs. Wanda K. Farr); Research on Insecticides (Dr. Albert Hartzell); and, Fungicide Investigations (Dr. S. E. A. McCallum). Entomologists and plant pathologists will be particularly interested in these two, last-named chapters.

Certain aspects of the main topics are, of necessity, covered breifly so that a more complete report of the specific studies by the Institute may be adequately presented and discussed. The pertinent work of investigators from other places is, however, adequately referred to and evaluated in the discussions.

Certainly all who work with plants will be greatly interested in this report, and will want available a copy of this very fine book.

HUGH G. GAUCH
Assoc. Prof. of Plant Physiology,
University of Maryland

THE ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

The nineteenth Rocky Mountain Conference of Entomologists was held in the mountains at the Cameron Pass Camp, about 85 miles West of Fort Collins, Colo., August 17–21 inclusive, 1948. Members of the families joined in a combined recreational and scientific meeting. A total of 118 representing 18 states and the District of Columbia were in camp. The entomologists in attendance were: A. Fullman Allred, Lauren Anderson, J. Everett Bussart, Ralph W. Bunn, H. S. Beaudoin, W. D. Buchanan, S. W. Clark, P. B. Cole, Leslie B. Daniels, H. F. Dietz, H. E. Dorst, D. G. Denning, L. F. Edmunds, J. R. Eyer, A. J. Flebut, F. A. Fenton, Fred Fletcher, John F. Glawe, F. Herbert Gates, J. W. Gibson, David C. Hall, Homer J. Henney, R. E. Hamman, Clyde C. Hamilton, Ephriam Hixson, Floyd Holmes, W. B. Hull, D. E. Howell, J. L. Hoerner, A. L. Hershey, Albert W. Johnson, Ralph R. Lloyd, C. D. Leedham, George M. List, C. L. Massey, D. R. Merkley, Gordon T. Mickle, Harlow B. Mills, Sam C. McCampbell, C. E. Nelson, Jr., J. H. Newton, W. E. Peay, Miriam A. Palmer, R. E. Pfadt, Geo. I. Reeves, D. G. Rice, T. R. Robb, P. A. Ray, Madelon Rey, Don C. Stehr, B. Thomas Snipes, Harold Schnorrenberg, John R. Stuntz, C. E. Titensor, Carl R. Tanner, Noel Wygant, Harry G. Walker, R. J. Walstrom, E. N. Woodbury, R. L. Wallis.

All programs were in the form of symposia and discussions. Seven sessions were held.

A committee consisting of J. R. Eyer, D. E. Howell and A. J. Flebut arranged the program each day from the titles for discussion that had been suggested. The principle theme was the newer insecticides, their physical and chemical properties, their formulation, uses, and limitations. The following gave the discussion on the chemical and physical properties and the formulations of the newer materials after which all told of their research and field experiences. Harry F. Dietz—DDT, methoxychlor, benzene hexachloride and DDD; Harry Walker, DDT; E. N. Woodbury—chlorinated camphene and related compounds; J. Everett Bussart, chlordan; Robert E. Hamman, chlordan and "Compound 118"; Fred Fletcher, benzene hexachloride, parathion, dinitro compounds, methyl bromide, ethylene dibromide, dichloro propene; Thomas Snipes—piperonyl butoxide and related compounds; Wm. J. Finely, Botanicals.

The discussion of the use of the new insecticides came under the following general headings and discussion leaders.

Livestock insect pests—D. E. Howell, T. R. Robb, Ephriam Hixson, Gordon T. Mickle, D. G. Denning, Clyde Hamilton, R. E. Pfadt, Harry Dietz.

Field crop insects—Claire E. Titensor, C. E. Nelson, Jr., William Hull, John F. Glawe, A. J. Flebut, J. R. Eyer, J. W. Gibson, D. G. Denning, Gordon T. Mickle, Howard E. Dorst.

Tomato insects—Howard E. Dorst

Thrips on tomatoes—Walter E. Peay

Celery insects—Howard E. Dorst, Geo. M. List

Mexican bean beetle—J. R. Eyer

Greenhouse insects—Clyde Hamilton

Rearing Macrocentrus ancylivorous—Lorin Anderson

Chlordan residues—Robert E. Hamman

The Englemann spruce beetle—Noel Wygant, David F. Hall

The European bark beetle and Dutch elm disease in Colorado—Geo. M. List

The Black Hills beetle—Calvin Massey

The spruce bud worm—W. D. Buchanan.

The pine tip moth—W. D. Buchanan, F. A. Fenton.

The pecan nut case bearer—F. A. Fenton.

Fruit Insects

The work in Colorado

The work on the West Coast—A. J. Flebut.

The cherry fruit worm—J. L. Hoerner.

Insect fauna of oak-hickory forest floor—Wm. C. Stehr.

Entomology in the Army—Ralph W. Bunn.

Those elected to arrange for the 1949 Conference were:

Chairman—Ephriam Hixson.
Vice-Chairman—Leslie B. Daniels.
Secretary—Geo. M. List.
Treasurer—John L. Hoerner.

GEO. M. LIST
Secretary

TWENTY-THIRD ANNUAL WESTERN COOPERATIVE SPRAY CONFERENCE

The Twenty-third Annual Conference of the Western Cooperative Spray Project was held at Portland, Oregon, on January 26 to 28 for a discussion of research work being done by the members on the spraying of deciduous fruit trees.

There was great interest in the performance of parathion and other acaricides in controlling orchard mites. Research work on aphids, scale insects, pear psylla, prune thrips, cherry fruit fly, codling moth, and peach, cranberry and filbert insects was also discussed, as well as research on fungous diseases and pear blight.

The suggestions for the use of orchard sprays, which are used as a basis for the recommendations issued by others, were revised and somewhat abridged, as the information on summer oil formerly given is no longer considered necessary. Emphasis was on the use of DDT and parathion.

On the last day the members were guests of the Pacific Insecticide Institute at a luncheon presided over by Mr. Ed Littooy, of the Colloidal Products Corporation. A number of talks on insecticides were heard and the suggestions were discussed. Over 200 attended the luncheon.

Attendance at the closed sessions was as follows: British Columbia Department of Agriculture, 3; Canadian Department of Agriculture, 2; Experiment Stations of California, 3; Idaho, 1; Montana, 1; Oregon, 14; Utah, 1; Washington, 23; and U. S. Department of Agriculture, 8. These included chemists, entomologists, horticulturists and plant pathologists. There were also about 25 accredited visitors, most of them from the State Departments of California, Oregon and Washington, and the U. S. Department of Agriculture.

E. J. NEWCOMER, Yakima, Wash., *Chairman*
F. L. OVERLEY, Wenatchee, Wash., *Secretary*

A NOTE ON THE ENTOMOLOGICAL SECTION OF THE NATIONAL AGRICULTURAL ADVISORY SERVICE OF ENGLAND AND WALES

American and Canadian entomologists have in the past been familiar with the set up of the Advisory Service in England and Wales and many have been the valuable contacts between workers in these countries; great changes tending to sever these contacts have taken place.

From the early 1920's until 1946, the specialist advisory (Extension) officers in the major applied sciences relating to agriculture were stationed at the principal universities having agricultural faculties or at agricultural colleges. For this purpose the country was divided into 13 provinces and the specialist advisory officer, like the extension specialist in the U.S.A., was a member of a team which included soil chemists, mycologists, entomologists, veterinary investigation officers, dairy bacteriologists and economists. This team was available to advise the county agricultural organisers (who correspond to the county extension agents in the U.S.A.) and to assist farmers by diagnosing and advising on problems which could not be dealt with locally. Many problems called for a considerable volume of field investigation and research, which must be the basis for really sound advice; the amount of original research carried out by the Advisory Officers was considerable. The specialists, however, were a part of the research staff of the agricultural faculty of the university or college to which they were attached and it was often found that the growing pressure of work meant that either the research or the advisory work suffered. Further, the advisory and extension services at the county level were largely financed by government funds on the basis of a formula which, unfortunately, often prejudiced those countries which depended almost entirely on agriculture and had a small urban population.

During the war, both the provincial advisory specialists and the county agricultural organisers became more closely integrated with the Ministry of Agriculture & Fisheries; in 1946 the Provincial Advisory Service and the County Agricultural Services were absorbed into a new organisation, The National Agricultural Advisory Service, which is administered by the Ministry of Agriculture & Fisheries and is independent of the universities and colleges. The number of the provinces has now been reduced to 8, although in several of the provinces which are large, it has been necessary to establish sub-centres.

Most of the entomologists who were serving as provincial advisers under the old system, have joined the new Service, which, in general, has provincial headquarters, including diagnostic laboratories at or near universities or colleges. The advisers will continue to carry out a certain amount of research work in addition to advisory work and the testing out of the suitability of new ideas and techniques throughout their own region. During the war, I am afraid, we inevitably lost contact with our entomological colleagues in North America, and the fact that many of us now have left the universities to become members of the new Agricultural Advisory Service, has broken many of the links which remained. All of us, however, are anxious to rebuild our professional contacts in the U. S. and elsewhere; all of us, I am sure, would be very glad to hear from old friends and to make new ones. I hope, therefore, that readers of your Journal will not hesitate to write to any of us at our new addresses about our common scientific problems or on any other matter in which they are interested. I might add that most of the entomologists are also interested in problems relating to plant parasitic nematodes, since they have difficult eelworm problems to face in their provinces. The individual advisers will also be pleased to assist contacts between their assistants and U. S. or Canadian workers, for many of the assistants are working on special problems. If I can be of any assistance in putting any North American reader who is interested in a particular field of entomology into touch with workers of similar interests in Great Britain, I should be only too glad to help, and so I am sure, would the Agricultural Attaché in the British Embassy, Washington, or the Agricultural Adviser to the High Commissioner for the United Kingdom, Ottawa, Ontario, Canada.

The old province which used to centre on Manchester, has been merged with other provinces and its largest county, Lancashire, now forms part of the Yorkshire and Lancashire Province. Mr. H. W. Thompson, M.Sc., is still in charge of the work of this new province. Dr. M. Cohen has been transferred from Manchester to take charge of the Northern Province. The headquarters for the Eastern Province have moved from Cambridge University, but are near Cambridge, Dr. H. C. Gough, lately assistant to Mr. H. W. Thompson, now being responsible for the entomological work.

The remaining entomologists continue in the provinces in which they worked under the old service. In some cases considerable territorial additions have been made. The addresses of the entomologists are as follows:

Northern Province—M. Cohen, M.Sc., Ph.D., Elswick Hall, Elswick Park, Newcastle-on-Tyne.

Yorks. & Lancs. Province—H. W. Thompson, M.Sc. Quarry Dene, Weetwood Lane, Leeds, 6.

East Midland Province—A. Roebuck, N.D.A., Shardlow Hall, Shardlow, near Derby.

West Midland Province—H. C. F. Newton, B.Sc., A.R.C.S., "Woodthorne," Wergs Road, Tettenhall, nr. Wolverhampton, Staffordshire.

Eastern Province—H. C. Gough, Ph.D., Anstey Hall, Trumpington, Cambridge.

South Eastern Province—W. E. H. Hodson, A.R.C.S., D.I.C., Chiltern Court, St. Peter's Ave., Caversham, Reading, Berkshire.

South Western Province—L. N. Staniland, A.R.C.S., D.I.C., Bracken Hill, Leigh Woods, Bristol, 8.

This address will change probably within a year to: Crete Hill, Westbury-on-Trym, Bristol.

Welsh Province—J. R. W. Jenkins, M.Sc., Crosswood, near Aberystwyth, Wales.

L. N. STANILAND, A.R.C.S., D.I.C.,
National Agricultural Advisory Service,
South Western Province,
Bristol, England.

Report of the Committee on Insecticide Terminology

During 1948, your Committee has given further consideration to the proposal and establishment of common names for insecticides that are known only by long, unwieldy chemical designations or by trademarked names. These activities have been concerned chiefly with policies and procedures in the naming of such insecticides and with the kinds of names that are suitable for them. Some progress has been made in the selection of names for four insecticides.

At least four governmental agencies and as many non-governmental agencies, including this Association, have an interest in common names of insecticides. In addition, each industry is interested in any name that may be established for one of its products. Of the governmental agencies, the Interdepartmental Committee on Pest Control of the U. S. Department of Agriculture has taken the lead in getting approval of common names of insecticides from interested agencies and industrial groups.

A consideration of these activities shows that the naming of an insecticide is at present a complicated process, involving extended correspondence with many persons. No single agency has been established which can approve common names of insecticides for general public use. Early this year, the Interdepartmental Committee on Pest Control met with representatives of various agencies in Chicago to review various questions, and work out procedures that might be followed in selecting and establishing common names for pest-control chemicals. Dr. H. L. Haller represented your Committee at this meeting. After a thorough-going discussion various proposals were made looking toward unification and concentration of effort. The entire matter is still under consideration.

Your Committee has given its approval of a name for an important new insecticide which has been under consideration by the Interdepartmental Committee for some months. Further work must be done by this Committee before the name is ready for official approval.

Consideration was also given to the proposal of names for three established insecticides of known chemical structure. Progress has been made in Committee, but names are not yet ready for consideration by other agencies.

Your Committee recommends continuing cooperation with other associations and agencies in the matter of establishing common names for insecticides.

Glenn F. Carman H. L. Haller
J. R. Eyer H. H. Shepard
C. H. Richardson, *Chairman*

Report of the Section of Apiculture

The Section of Apiculture met in Parlor A., New Yorker Hotel at 1:30 December 13, 1948. In the absence of the Chairman Dr. E. J. Dyce who was attending an apicultural meeting in St. Louis, Dr. E. F. Phillips presided and read the Chairman's address. In addition to this, five papers were presented. Of these, four were concerned with the subject of bee poisoning which proved to be the focus of much interesting discussion.

In the business session a motion was made, seconded and passed that the address of Chairman Dyce be mimeographed and distributed to interested parties, particularly to experiment station directors, to extension entomologists and to beekeepers' associations; Dr. Dyce to be consulted regarding the advisability of recasting the paper to suit the various audiences.

The nominating committee presented and the voting members elected for Chairman and Secretary, respectively,

Everett Oertel and W. A. Price

Fifty-five persons attended the meeting, which was in continuous session until 5 P.M. when it was adjourned.

W. A. Price
Secretary

The Thomas J. Headlee Fellowship Report

The Thomas J. Headlee Research Fellowship Advisory Council held in its third annual meeting at Rutgers University on December 17, 1948. Mr. Franklin C. Nelson of Roselle, New Jersey was re-elected chairman of the council. Mr. Nelson, representing the Standard Oil Company of New Jersey, is one of 25 representatives of commercial and industrial organizations contributing to the support of the fellowship fund. Other industrial organizations contributing to the support of this fellowship are: American Cyanamid Company, Carbide and Carbon Chemicals Corporation, Chipman Chemical Company, Dow Chemical Company, Goulard & Olena, Cooperative GLF Exchange, Inc., Gulf Research and Development Company, Hercules Powder Company, Inc., H. D. Hudson Manufacturing Company, Koppers Company, Inc., P. E. Lirio, McCormick & Co., Inc., Merck & Co., Inc., Miller Chemical and Fertilizer Corporation, New Jersey Mosquito Extermination Association, New Jersey Pest Control Association, Inc., Niagara Sprayer & Chemical Co., Inc., John Powell & Co., Inc., R. J. Prentiss & Co., Quality Lime Institute, Rohm & Haas Co., Seacoast Laboratories, Inc., Texas Gulf Sulphur Co., Inc. and Tobacco By-Products & Chemical Corporation.

The fellowship, established in 1944 to honor the late Dr. Thomas J. Headlee, for many years head of the Rutgers University Department of Entomology, is dedicated to the advancement of fundamental research in entomology. First holder of the fellowship was Mr. John P. Reed, University of Maine graduate, who resigned last February to accept a full-time position with the Rutgers Entomology Department. Mr. Reed was succeeded by Mr. A. J. Forgash, a graduate in Chemistry from Rutgers.

Mr. Forgash and Mr. Reed reported to the council on progress made since the last meeting in December, 1947. The problem under investigation is the role of glutathione as an inactivator of certain insecticides introduced into the insect's body.

Dr. Henry H. Richardson of the Bureau of Entomology and Plant Quarantine, located at Hoboken, N. J., was detailed to Argentina for several months beginning in January. His duties will be to organize the facilities and procedures for treating grapes and deciduous fruits originating in areas quarantined because of the Mediterranean and other fruit flies, to permit entry of such fruit into the United States.

PROCEEDINGS OF THE TWENTIETH ANNUAL MEETING

EASTERN BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Hotel New Yorker, New York City

November 18 and 19, 1948

The Twentieth Annual Meeting of the Eastern Branch, A.A.E.E. began at 10:00 A.M. November 18, in the Hotel New Yorker, New York City. Mr. C. M. Packard, Chairman, presided over the two day session, assisted by Mr. Frank C. Nelson, Vice-Chairman. A total of forty papers were read and discussed during the two days.

At the short business session at noon, November 18, Chairman Packard appointed the following committees:

Nomination: C. GRAHAM, PAUL MAYFIELD, S. A. ROHWER, *Chairman*

Auditing: M. D. FARRAR, G. T. FRENCH

Resolutions: H. M. STEINER, H. G. WALKER, G. E. R. HERVEY

Awards: ROBERT A. FULTON, T. W. REED, J. A. COX, *Chairman*

The Secretary-Treasurer made the following report, which was referred to the Auditing Committee.

REPORT OF THE SECRETARY-TREASURER

Notices of the Twentieth Annual Meeting to be held in New York on November 18 and 19, 1948, were sent to approximately 750 members of the American Association of Economic Entomologists residing in the eastern branch territory. A total of forty paper titles were received which enabled the Secretary to arrange a two day program without limiting the time requested by each speaker. Dues paying members for 1947–48 totalled 235.

The ninth annual award for the outstanding paper presented at the 1947 meeting went to Professors E. H. Smith and G. W. Pearce for their joint paper: "The Mode of Action of Petroleum Oils as Ovicides" which was the first paper published in the April, 1948 issue of the JOURNAL OF ECONOMIC ENTOMOLOGY.

FINANCIAL STATEMENT

Balance on hand, November 15, 1957		$ 3,245.20
Receipts		
Dues for 1947–1948—November 1947 Meeting	$ 294.00	
Dues for 1948–1949	158.00	
Receipts from *Entoma*	8,000.00	
Total Receipts	$8,452.00	$11,697.20
Disbursements		
Benjamin- Franklin Hotel (Sound Equipment)	$ 30.00	
Williams, Brown & Earle Inc. (Projection Equipment)	40.00	
Payment to Secretary-Treasurer 1948	200.00	
Payment to Editor 1948	50000	
Mrs. R. L. Busbey, Entoma Services.	100.00	
Clerical Services		
Eastern Branch	59.30	
Entoma	92.98	
Postage and Stamped Envelopes		
Eastern Branch	43.77	
Entoma	685.00	
Expenses of Secretary 1947 meeting	$27.81	
9/8 N. Y. meeting	4.64	
11/5 Phila. meeting	5.45	37.90
Entoma Committee Meeting Expenses		
—C. C. Hamilton	14.12	
Wm. M. Boyd	11.22	
Annual Award	150.00	
Duplicate Payment of advertisement.	60.00	
Duplicate Payment of Dues	12.00	
Printer		
Eastern Branch	47.09	
Entoma	5,125.65	
Total Disbursements	$7,209.03	
Balance on hand, November 15, 1948		$ 4,488.17
Distributed as follows:		
Checking Account, the Union National Bank and Trust Company, Mount Holly, N. J.	$4,513.21	
Less outstanding checks:		
11/8 C. C. Hamilton	$14.12	
11/12 Wm. M. Boyd	11.22	
11/15 E. B. Fagan	33.70	59.04
	$4,454.17	
Cash on hand in office	34.00	
		$ 4,488.17

BYRLEY F. DRIGGERS
Secretary-Treasurer

At the final business session on Friday, November 19, 1948, the following committee reports were received, discussed and voted that they be accepted.

REPORT OF THE AUDITING COMMITTEE

November 17, 1948

1 We have examined the records of the Secretary-Treasurer for the Eastern Branch of the American Association of Economic Entomologists and found them correct.

2. We have examined the records of the Editor of *Entoma* and have found his records to be correct.

3. That the Secretary-Treasurer be instructed to discard from his files such old records as correspondence, cancelled checks and receipts that no longer are of value to the business of the Eastern Branch of the American Association of Economic Entomologists. The limit for keeping these records shall be three years. This rule shall also apply to those records maintained by the Editor of *Entoma*.

Recommended by Auditing Committee
M. D. FARRAR
G. T. FRENCH

REPORT OF THE RESOLUTIONS COMMITTEE

1. Whereas the deaths of Hugh Glasgow, S. W. Harman, C. W. Collins and L. W. Brannon have left us with deep feelings of loss—Be it Resolved: that we express, through our Secretary, our regrets and sympathies to the families of these members.

2. Whereas we recognize our broader responsibilities as suggested by the Resolutions Committee of the parent Association in 1947 and restated by S. A. Rohwer at this meeting—Be it Resolved that we guard against the danger that preliminary reports on experimental remedies and devices reported by members to facilitate the researches of others may

be given to the public as recommendations until these are proven safe to agriculture, man, fish, wildlife and the user and do not present hazards from residues resulting from their use.

3. Whereas, an improvement in illustrative material used in presenting papers has been noted but there is still a tendency by some members to crowd too much material on one slide—Be it Resolved, that no more data be presented on each slide than can be seen clearly from all parts of the meeting room.

4. Whereas, our accommodations at this meeting have been well provided Be it Resolved, that we express our appreciation to the Committee on Local Arrangements and to the Hotel New Yorker for these excellent accommodations.

5. Whereas, the Review of Applied Entomology is and has been a highly useful publication to entomologists—Be it Resolved, that a Committee be appointed to study ways and means of showing our appreciation to publishers of this worthy publication during these difficult times.

HAROLD M. STEINER
G. E. R. HERVEY
HARRY G. WALKER

REPORT OF THE SPECIAL COMMITTEE ON THE ANNUAL AWARD

November 19, 1948

It is the opinion of this committee, and of many members of the Eastern Branch that the Annual Award no longer serves its intended purpose.

It is therefore recommended that the Annual Award be discontinued after the 1948 meeting.

H. H. SCHWARDT
W. E. FLEMING
H. G. GUY

REPORT OF THE EDITORIAL COMMITTEE OF *Entoma*

At the meeting of the Eastern Branch Section, American Association of Economic Entomologist, November 20, 1947, there was considerable discussion regarding the publication of *Entoma* and the finances of the Eastern Branch. Following this discussion, a motion was made and passed, as reported on page 343 of the Eastern Branch Proceedings, April issue of the JOURNAL OF ECONOMIC ENTOMOLOGY, 1948:

"That the Committee on *Entoma* study the question of the handling of the finances of *Entoma* and the finances of the Association and report at the next meeting."

The Committee has had considerable correspondence relative to the duties imposed upon it by the Chairman of the Eastern Branch and met in Baltimore November 3, 1948. The following is the report of this Committee:

The Committee recommends:

1. That the Eastern Branch proceed with the publication of the 8th edition of *Entoma*.

2. That Dr. George S. Langford serve as Editor of the eighth edition.

3. That for each edition of *Entoma* the Editor be paid $500.00 plus a commission of 5 per cent of the gross income for his services. This commission not to include normal expenses such as clerical help, postage, printing and other items normally involved in the assembling, publication and distribution of *Entoma*.

4. That the sale price of *Entoma* be increased to $1.50 post paid.

5. That $3000.00 now in the Treasury of the Eastern Branch be set aside as a fund which can be called upon by the Editor of *Entoma* to initiate the publication of the eighth edition.

6. That the present Executive Committee and the incoming Vice-Chairman confer with the Executive Committee of the A.A.E.E. with respect to transferring the publication of *Entoma* to the A.A.E.E. in accordance with the report of the "Special Committee on *Entoma*" presented at the 14th Annual Meeting of the Eastern Branch held in 1942 (Proceedings of the Eastern Branch, JOURNAL OF ECONOMIC ENTOMOLOGY, Volume 36, April, 1943, pages 363–364).

7. That, since the other branches of the American Association of Economic Entomology, do not pay for publication in the JOURNAL OF ECONOMIC ENTOMOLOGY, of papers presented at their annual meetings, the present Executive Committee of the Eastern Branch and including the new Vice-Chairman confer with the Executive Committee of the A.A.E.E. to arrange for publication without cost of papers presented at the Annual Meeting of the Eastern Branch.

8. That a registration fee of $2.00 be collected from each person attending the annual meetings who has not already paid his dues of $2.00.

GEORGE S. LANGFORD
J. L. HORSFALL
R. C. ROARK
H. B. WEISS
M. P. JONES
R. L. BUSBEY
C. V. BOWEN
WM. BOYD
H. H. SHEPARD
C. C. HAMILTON, *Chairman*

Upon invitation of Chairman Packard, Dr. S. A. Rohwer, of the Bureau of Entomology and Plant Quarantine and President of the American Association of Economic Entomologists for the current meeting, made a brief talk in which he extended the greetings of the Association and his own personal good wishes.

REPORT OF NOMINATING COMMITTEE

Your committee proposes the following names as officers of the Eastern Branch of the American Association of Economic Entomologists for the coming year.

For Chairman: FRANK C. NELSON
For Vice-Chairman: EDWIN GOULD
C. GRAHAM
P. MAYFIELD
S. A. ROHWER, *Chairman*

MEMBERS AND GUESTS REGISTERED AT THE TWENTIETH ANNUAL MEETING, EASTERN BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, NOVEMBER 18 AND 19, 1948

Adams, J. A.
Aldrich, W. W.
Alexander, C. C.
Arnold, R. B.
Asquith, Dean
Avens, Alfred W.

Badertscher, A. Edison
Barber, George B.
Barthel, W. F.
Bashour, J. T.
Beacher, John H.
Beard, R. L.
Benjamin, Hugh H.
Berry, Robert C.
Bixby, A. F.
Blauvelt, W. E.
Bobb, M. L.
Boyd, Wm. M.
Brandes, Gordon A.
Brett, R. L.
Bromley, S. W.
Brooks, Robert
Bryant, Clyde
Buchholz, A. B.
Buettner, Wm. O.
Burch, Ernest
Bussart, J. Everett
Butler, George

Campbell, F. L.
Camson, E. J.
Cappy, Frank H.
Carruth, L. A.
Clark, Elton
Cohill, Roger W.
Collins, D. L.
Compton, C. C.
Conklin, J. G.
Cowan, E. K.
Craig, F. W.
Crissman, Wm.

Darley, M. M.
Dean, R. W.
DeLong, D. M.
Deuber, C. G.
Dickinson, B. C.
Dietz, Harry F.
Dohanian, S. M.
Domick, C. B.
Donohoe, H. C.
Dorland, Wayne E.
Dotz, Alfred E.

Earle, Hilton, Jr.
Eastman, P. M.
Echols, H. A.

Farley, Arthur J.
Farr, Thomas H.
Farrar, M. D.
Fassig, W. W.
Ferguson, G. R.
Fischer, C. D.
Fletcher, Fred
French, G. T.
Friend, R. B.
Fulton, R. A.

Gambrell, F. L.
Gemmell, Louis G.
Gesell, S. G.
Gillan, R. J.
Ginsburg, J. M.
Glasgow, A. D.
Glass, E. H.
Gleissner, Bruce
Gould, Edwin
Graham, C.
Granett, Philip
Grayson, James McD.
Greenwald, Margaret
Guengerich, H. W.
Guy, H. G.
Guyton, T. L.

Haas, C. Y.
Hadley, C. H.
Hahn, Peter
Hamilton, C. C.
Hamilton, Donald W.
Hammer, O. H.
Hansens, Elton J.
Harris, C. S.
Hartley, R. O.
Hastings, A. R.
Haude, W. J.
Heal, Ralph
Hervey, G. E. R.
Hill, Clarence H.
Hoeffler, J. H.
Hoegberg, Erich
Hofmaster, R. N.
Horn, Meriam B.
Horsfall, J. L.
Hovey, Chas. L.
Howe, Wayne L.

James, W. S.
Jennings, C. C.
Jobbins, D. M.
Jones, M. P.

Kisliuk, Max

LaForge, B. A.
Langford, George
LaPlante, Albert
Larson, N. P.
Lathrop, F. H.
Leiby, R. W.
Leonard, M. D.
Lewis, C. M.
Long, John C.
Lutan, I. H.

MacCreary, Donald
Mahoney, C. H.
Mail, G. Allen
Majure, W. J.
Malcoln, D. M.
Manzelli, M. A.
Marucci, Philip Edward
Maughan, F. B.
McDonald, Norman
Melvin, Roy
Miller, A. C.
Moore, Warren
Mort, D. W.
Mundinger, F. G.

Nelson, F. C.
Nelson, James A.

Packard, C. M.
Parker, L. B.
Parr, Thaddeus
Pass, Herbert A.
Payne, Nellie M.
Pearce, G. W.
Pechuman, L. L.
Pepper, B. B.
Pepper, J. O.
Peterson, P. D.
Pierce, Henry F.
Pierpont, R. L.
Poland, J. Lloyd
Porter, R. P.
Potts, S. F.
Pyenson, Louis

Razim, W. Wendell
Rech, R. W.
Reed, T. W.
Rex, E. G.
Riedeburg, T.
Roark, R. C.
Roder, E. V.
Roger, George H.
Rohwer, S. W.
Roth, Roger W.
Rutschky, Charles

Sacktor, Bertram
Sanders, J. G.
Schmitt, J. B.
Schoen, W. J.
Schwardt, H. H.
Seaver, Henry B.
Sesson, H. A., Jr.
Sharp, S. S.
Sherman, Martin
Simches, George
Singleton, J. N.
Smith, Edward, H.
Smith, Thomas L.
Soraci, F. A.
Starr, Donald F.
Steiner, Harold M.
Stoddard, J. R.
Stokes, R. L.

Tafuro, A. J.
Taschenberg, E. F.
Thompson, B. T.
Thompson, Friar
Toffaleti, James
Tomlinson, W. E., Jr.
Torrey, J. W.
Tracy, Ralph L.
Turner, Neely

Van Winkle, Dixon
Vinzant, J. P.

Walker, Harry G.
Wallace, Philip
Wallace, Robert T.
Wean, Robert E.
Weed, Alfred
West, Harry
Westcott, Cynthia
Wheeler, Ellsworth H.
Wilcoxon, Frank
Wood, G. C.
Woodbury, E. N.
Woodruff, Nancy
Woodside, A. M.
Worthley, H. N.

Zappe, M. P.
Zimmerman, William E.
Zukel, J. W.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION

The 1949 meeting of the New Jersey Mosquito Extermination Association was held on March 23, 24 and 25 at Atlantic City, New Jersey, in the Hotel Haddon Hall.

PROCEEDINGS OF THE SIXTIETH ANNUAL MEETING

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The Hotel New Yorker, December 13, 14 15 and 16, 1948

PRELIMINARY BUSINESS SESSION, DECEMBER 13

President Rohwer announced the chairmen of the several paper reading sessions as follows: Insect affecting Forests, Ornamentals, etc., W. J. O'Neill; Cereal and Forage Crops, J. N. Roney; Fruits, F. C. Nelson; Insecticide Section, C. S. Harris; Vegetable, H. M. Harris; Miscellaneous Insects, J. T. Creighton. He served notice with regard to the time limitations and then briefly discussed the replies to his letter asking for suggestions or criticisms.

Throughout the year I have received 900 letters. Obviously, it has been impossible for me to acknowledge them all. I started out with the idea of acknowledgment in a formal way; a few more got a long-hand postcard; most of you didn't get anything. But I want you to know I appreciate them; it has helped me very much to learn what the people of the Association thought about the Association. If things have been done during the year that have been constructive, part of it stems from the enthusiastic response to that invitation.

In accordance with the requirements of the rules of the Association, I have attended each of the branch meetings. I had the privilege also to attend the meeting of the Ontario Entomological Society which was held jointly with the Entomological Society of Montreal, so I have had an opportunity to send the greetings of this Association to our branches and to our associates in the North.

Early last year I conceived the brainstorm that it would be nice to get together with the Phytopathologists, at least in a joint session. The Phytopathologists tried to arrange meetings in New York to coincide with ours. Hotel conditions made that impossible. They have, however, modified their organizational structure so that it is possible for them to plan a little bit in advance and they hope to meet with us when we meet in 1951 in the central area of the United States.

It is customary for the chairman to appoint a Resolutions Committee. I have appointed the following committee:

J. N. RONEY — J. L. HORSFALL
W. V. KING — W. N. KEENAN
GEO. C. DECKER, *Chairman*

If any member has any recommendation that he would like to present before the Resolutions Committee he should do so as soon as convenient.

During the year your President has taken certain action which he wishes to report to you. I appointed Mr. O. A. Hills to represent the Association at the installation of the President of the University of Arizona.

At the Chicago Meeting we appointed as delegates to the International Congress of Tropical Medicine and Malaria, Robert Matheson, W. B. Herms, E. N. Cory; and by direction your President represented the Association at that meeting.

You will recall that at the Chicago meeting we appointed as representative of the Association to the Thirteenth International Congress of Zoology which was held in Paris in July, Z. P. Metcalf and W. P. Hayes. I appointed as an additional delegate, E. N. Cory.

We appointed J. C. Bradley and Robert Usinger to attend the eighth International Congress of Entomology. In addition to those two, I appointed P. N. Annand and E. N. Cory, and designated Cory as chairman of our group.

In this connection I would like to advise you that we cooperated with the Entomological Society of America and extended an invitation to the Congress to meet the next time in the United States. It had made previous commitments and the next Congress meets in Amsterdam, Holland. We received a very appropriate and appreciative letter of declination.

Early in April the Surgeon General of the Army invited the Association to be represented at a conference to consider matters relating to sciences in the Medical Service Corps of the Army. Cory and I attended the two-day meetings. The other society was also represented by two delegates. As an outgrowth of the discussion of those two days there was appointed a committee of five to make a report. It is significant that our Association was recognized in that E. N. Cory is on that committee. He advises us that the committee has prepared and submitted a report which is now being considered by the Surgeon General, and which may later be made public.

At the Centennial of the AAAS your councilor, B. B. Pepper, was present and I also registered on behalf of the Association.

The National Cotton Council invited the Association to send a representative to the meeting recently held in Atlanta. Charles Alden was designated as that representative and attended the sessions.

At the Chicago meeting we gave consideration to the American Institute of Biological Sciences. You will recall that the action at that meeting was that we would not at this time affiliate. Subsequently the officers of that organization invited us to have an observer at their meetings. I appointed B. A. Porter and he has prepared a short statement.

Food and Agricultural Organization in the United Nations have been meeting in the United States this fall. They invited the Association to send an observer. I appointed S. B. Fracker, who will report on the meeting.

REPORT OF DELEGATE TO FAO

At the request of President Rohwer and in response to an invitation from FAO, the undersigned represented the American Association of Economic Entomologists, as an observer, at the Fourth Annual Session of the Food and Agriculture Organization of the United Nations held at Washington on November 15 to 29, 1949. Several of the actions taken by the conference were of interest to entomologists.

FAO has a permanent secretariat consisting of an administrative and technical staff covering most agricultural fields. The Organization works through national governments and does not undertake independent research. Stephen C. Easter (formerly in white-fringed beetle research in the U. S. Department of Agriculture) is in charge of the entomo-

logical activities of the FAO. Work in progress and proposed for 1949 in the field of insect control may be outlined as follows:

Locust Control. FAO is working with several international organizations in grasshopper control. The Near East is especially interested in this problem, and a conference on desert and Moroccan locusts, sponsored by FAO, is expected to be held in the near future. It was postponed from the summer of 1948 due to military developments in the area. Two international organizations are actively engaged in eradicating grasshoppers in African planting areas; one just north of the equator, and the other in Northern Rhodesia.

A Latin American conference on grasshoppers is also scheduled for The Conference adopted a resolution urging international cooperation in such pest control measures, especially by loaning each other equipment and by removing obstacles, such as custom formalities, that might impede the exchange of such equipment between adjoining countries.

Infestation in Stored Products. Efforts are being made to induce FAO countries to organize effective methods of infestation control. The U. S. has participated in two conferences of experts on this subject, one in the U. S. and one in London. A conference intended to stimulate the adoption of measures recommended by the experts was held in Florence, Italy, in September 1948, and another is planned for Latin America, to be convened in Palmira, Colombia, in February 1949. This is expected to be followed by a short course for training Latin American technicians in the control of stored-product pests.

The Far Eastern group of countries represented at the Annual Conference was also impressed by the lack of proper storage facilities in Asia for produce at all stages from the farm to the consumer and the heavy losses that were resulting from infestation. Governmental action to aid in reducing these losses was recommended by the Conference.

Tsetse Flies. The African delegates reported that in vast areas stock farming is practically impossible because of tsetse flies and rinderpest. An international organization, with headquarters at Brazzaville-Leopoldville, is engaged in the fight against the tsetse fly.

Pesticide labeling. The FAO plans an effort to obtain agreement on assaying and labelling pesticides. This will encounter some difficulties owing to the legal requirements within various countries, but a movement in this direction would be helpful.

Plant quarantines. A questionable project proposed by FAO is a "study to achieve greater uniformity in plant quarantine regulations." It is improbable that uniformity can be achieved in this field owing to the wide diversity in crop pests and climatic conditions in different parts of the world. It is believed, however, that international consideration to the most effective methods of preventing the dissemination of crop pests would be valuable. This would involve not only a study of quarantine restrictions as such, but also the development of measures for the disinfestation of agricultural products that might have been exposed to pest attack.

Pest reporting. A new proposal of interest to this Association is one initiated in South America under which FAO would consider how an international plan for promptly reporting outbreaks of plant and animal pests and diseases could be worked out. This survey of the possible approaches to the problem is to be made during 1949, and FAO is expected to report at the 1950 conference on the practicability of improving the international exchange of information of this kind. Such a plan of international reporting on the pest situation will be very helpful in many ways if it can be set in operation.

Entomological Advice. During the past year the Polish government asked for and obtained the services of several agricultural specialists. Among them an entomologist was sent by FAO to advise them on the control of the Colorado potato beetle.

At the request of the Chinese government, an entomologist and other specialists were sent by FAO to supply information of spraying and dusting machinery, insecticide manufacture, and the training of workers in insect and plant disease control.

FAO proposed the publication of practical pest-control handbooks for field workers and a bulletin on the chemical control of weeds. There are difficulties in carrying out the preparation of these publications owing to entomological and ecological differences in various parts of the world, and may better be left individual governments.

STANLEY B. FRACKER

REPORT OF THE SECRETARY-TREASURER

The total membership of the Association is 2172. There are additional applications pending that will probably bring the total to approximately 2200. There have been 30 resignations, 14 deaths and 134 applications approved leaving a net increment of 96 up to December 10, 1948

Publication costs have increased approximately 45 per cent since 1945. In that year the per page cost was $8.20 based on a total cost of $6,828.37 for printing, engraving and mailing. In 1946 the cost was $9.25 per page based on similar costs of $8,833.98. In 1947 the cost went up to $12.04 per page based on costs of $13,048.83 without consideration of overhead. The first two issues of the current volume cost $12.70 per page. The last three numbers of the current volume will cost 12.5 per cent over the contract prices for the first three numbers. The Executive Committee has received and considered bids from two other printing companies, the lower of which, estimated on the make up of the April issue, is higher than the present printers cost at the advance of 12.5 per cent.

The October page proofs have been mailed to the Editor and the December galley proofs were mailed on December 10. This indicates that we are catching up to the normal schedule. In consideration of this speed up and the favorable bid of the present printers, the Executive Committee decided to continue the present contract with the George Banta Publishing Company.

Index VII is in the hands of the Murray Printing Company and delivery should begin about February 15. This volume will cost the Association considerably more than previous volumes even though the contract is for photo-printing. The non-member price has been set at $7.00 per volume.

The annual report of the Certified Public Accountant was then presented and various items explained. In accord with the recommendation of the firm of accountants, major changes in the accounting system have been installed that we hope will make possible a better analysis of receipts.

Acceptance of the appended report was moved by Annand; Seconded by Mote; Carried.

THE REPORT OF THE AUDITORS

December 9, 1948

Dr. S. A. Rohwer, President
American Assn. of Economic Entomologists
3103 Key Boulevard
Arlington, Virginia

Dear Dr. Rohwer:

In accordance with your request of April 19, 1948, we have made an examination of the accounting records of the Secretary-Treasurer of the American Association of Economic Entomologists for the fiscal year ended November 30, 1948, and present herewith statements of receipts and disbursements of the General Fund, Permanent Fund and Special Journal Fund for the year, which we have prepared from the records.

Our examination was made in accordance with generally accepted auditing standards, and included such tests of the accounting records and other auditing procedures as we considered necessary.

In our opinion, the accompanying statements accurately reflect the recorded cash receipts and the authorized disbursements made for the benefit of the Association during the period. The balances of cash and securities at the beginning and at the end of the period were verified by us by actual count or were confirmed direct to us by the bank.

Yours very truly,
SMITH, PYLES & HERL
Certified Public Accountants
By Paul E. Pyles

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

GENERAL FUND
Statement of Receipts and Disbursements
For the fiscal year ended Novemner 30, 1948

		Total	*Journal*	*Association*	*Indices*
Receipts:					
Subscriptions		$12,617.62	$12,617.62		
Advertising		1,949.76	1,949.76		
Reprints		1,077.06	1,077.06		
Back numbers and miscellaneous		1,036.35	1,036.35		
Dues—1949	$2,892.00			$2,410.00	$ 482.00
1948	1,633.00			1,224.75	408.25
1947	198.00			148.50	49.50
1946 and prior years	69.00			51.75	17.25
		4,792.00		$3,835.00	$ 957.00
Sale of indices		158.80			158.80
Interest on bonds		50.00		50.00	
Federal income tax withheld but not yet paid		58.60		58.60	
Fee for addressing envelopes		24.50		24.50	
Total receipts		$21,764.69	$16,680.79	$3,968.10	$1,115.80
Disbursements:					
Printing and journal mailing costs		$16,206.02	$16,206.02		
Engravings		775.33	775.33		
Salaries and wages—stenographic and clerical		3,281.76	1,640.88	$1,640.88	
Honorarium—Editor, 1947 and 1948		1,200.00	1,200.00		
Honorarium—Business Manager and Secretary-Treasurer					
—1947		600.00	300.00	300.00	
—1948		600.00	300.00	300.00	
Postage, stationery and office supplies		1,084.41	542.20	542.21	
Travel expense		110.15		110.15	
Meetings expense		524.71		524.71	
Branch expenses reimbursed—Cotton States		149.61		149.61	
—North Central States		39.03		39.03	
Accounting service		135.00	67.50	67.50	
Registration fees of delegates to meetings of other societies		84.40		84.40	
Penalty and interest on withholding tax incurred in 1947		58.93		58.93	
Donation—American Society of Naturalists		25.00		25.00	
Telephone and telegraph		20.81		20.81	
Expenses of editing Index VII		15.15			15.15
Insurance		12.50	6.25	6.25	
Rent of safe deposit box		7.20		7.20	
Refund of Federal Old Age Benefit Tax withheld in 1947		7.50		7.50	
Federal income tax withheld in 1947 (paid in 1948)		284.00		284.00	
Equipment		303.79	303.79		
Cash shortage arising at December 1947 meeting		13.00		13.00	
Total disbursements		$25,538.30	$21,341.97	$4,181.18	$ 15.15
Excess of receipts or (disbursements)		($ 3,773.61)	($ 4,661.18)	($ 213.08)	$1,100.65
Transfer from Permanent Fund		4,000.00	4,000.00		
Balance, November 30, 1947, per previous audit report		9,754.04	1,115.91	6,301.73	2,336.40
Balance, November 30, 1948		$ 9,980.43	$ 454.73	$6,088.65	$3,437.05
Balance consists of:					
Cash in Prince Georges Bank & Trust Co. (checking acct.)		$ 7,980.43			
U. S. Savings Bonds, Series G, 2½% (at cost)		2,000.00			
		$ 9,980.43			

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Permanent Fund

Statement of Receipts and Disbursements
For the fiscal year ended November 30, 1948

Balance, November 30, 1947		$27,081.51
Receipts:		
Interest on bonds (See Note)	$ 268.14	
Interest on savings deposit	31.81	
Increment to redemption value of U. S. Savings Bonds, Series D. (added to book value)	400.00	
Life memberships:		
Four at $100 each	400.00	
Nine at $ 50 each	450.00	
		1,549.95
		$28,63.46
Disbursements:		
Transfer to General Fund		4,000.00
Balance, November 30, 1948		$24,631.46

Balance consists of:

Face Amount		*Book Value*	
Securities:			
$ 2,000	Province of Ontario 5% Debenture Bonds of 1959, at cost	$2,000.00	
3,000	U. S. Treasury 2¼% Bonds of 1955–1960, at cost	2,984.00	
10,000	U. S. Savings Bonds, Series D, Due February 1, 1949, at current redemption value	9,800.00	
7,000	U. S. Savings Bonds, Series G, 2½%, at cost	7,000.00	
			$21,784.00
	Cash in Prince Georges Bank & Trust Co. (savings account)		2,847.46
			$24,631.46

Note: In addition to the interest received shown above, there were on hand at November 30, 1948 matured bond interest coupons in amount of $93.11. The value of these coupons is not included in the above statement.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Special Journal Fund

Statement of Receipts and Disbursements
For the fiscal year ended November 30, 1948

Balance, November 30, 1947	$512.55
Receipts:	
Interest	5.05
	$517.60
Disbursements:	
None	—
Balance, November 30, 1948	$517.60

REPORT OF THE EXECUTIVE COMMITTEE
December 11, 1948

This report was read in sections that related to several activities as they came under consideration in the order of preliminary business. All items were approved so the report is presented herewith in its entirety and discussions of several items are appended as reported by the stenographers after the respective committee reports.

1. The report of the auditor was read and thoroughly discussed. It was finally passed for presentation to the Preliminary Business Meeting. The discussion centered about the need for a budgeting of probable needs due primarily to tle fact that large expenditures will have to be made for the publication of Indices.

2. The Secretary was authorized to select the Certified Public Accountant with the approval of the President. The Secretary was instructed to give the auditor such instructions as may be necessary in negotiating the contract.

3. It was recognized that dues and subscription are separate items. In preparing new application blanks for membership the dues are to be stated as $3.00 and the subscription as $3.50. An applicant may or may not subscribe to the JOURNAL. This is to take effect in the calendar year 1949. The non-member subscription rate was raised to $8.00 beginning the calendar year 1950.

4. It was moved by Howard and seconded by Lyle, and carried, that we continue our contract with the George Banta Publishing Company through the year 1949.

5. Considerable discussion ensued about the cost of *Index VII*. This *Index* is to be photoprinted and should be available for mailing about February 15. The price to non-members will be $7.00.

6. The Secretary is authorized to ask the Association at the time the call of the next meeting is sent out for the use of whatever part of the Permanent Fund is necessary beyong current available funds to defray the cost of *Indices* 7 and *8*.

7. The incoming President is authorized to appoint an editorial board not exceeding five in number for *Index 8*, one member of which is to be listed as the author.

8. It is recommended that the entire list of foreign members as published in the February 1948 JOURNAL be transferred to the active list with dues remitted. These members, with the exception of any who are now subscribers, are not to receive the JOURNAL. They will be eligible to subscribe to the JOURNAL at the member rate.

9. It is moved that the report of the Membership Committee nominating Dr. L. O. HOWARD and Dr. HERBERT OSBORN for honorary membership be accepted and brought to a vote of the Association.

10. The following members, in recognition of long and distinguished service in the Association, will be continued as active members with remission of dues: TREVOR KINCAID, H. A. MORGAN, GEORGE A. DEAN, W. B. HERMS, H. J. QUAYLE, P. J. PARROTT, and A. W. MORRILL.

11. In publication of future lists, the only differentiation in the active list is to be an asterisk before the names of life members and two asterisks before names of honorary members.

12. In order to clarify a situation with respect to the makeup of the Program Committee, the Executive Committee instructs the Nominating Committee to add one member to the Program Committee for a three-year term and to designate a Chairman from the two hold-over members.

13. In a discussion of a joint program committee with Secretary Ross, it was the consensus that the Executive Committee would welcome the appointment by the Entomological Society of America of a Program Committee empowered to work with the Program Committee of this Association.

14. The report of the Committee empowered to prepare a history of entomology in World War II was accepted and the continuation of the project authorized with the present two members of the committee to be continued. The expense incurred by the committee in an amount not to exceed $750.00 was authorized.

15. The letter from Dr. Paul DeBach in regard to the formation of a Section on Biological Control was read and discussed. Since no formal petition was presented as required by the Constitution action was deferred until such time as a formal petition may be presented.

16. After a two day discussion of the place of scientists in the armed services with particular reference to the Medical Service Corps, a committee of five was designated to summarize the proceedings and make recommendations to the Surgeon General. These recommendations are now in the hands of the Surgeon General. Until they have been officially released through channels, no formal announcement with regard to them is possible. The meeting was attended by H. H. Ross and P. W. Oman representing the Entomological Society of America and S. A. Rohwer and E. N. Cory representing this Association. E. N. Cory was designated as a member of the five-man committee.

17. The request for a complimentary subscription for indexing in the Agricultural Index was denied.

December 12, 1948

18. Dr. John T. Creighton presented a comprehensive survey of the hotels in the major cities in the southeastern area. Tampa was selected as the location of the 1949 meeting to be held December 13 to 16 inclusive.

19. The incoming President was authorized to appoint an individual to make a survey of the hotel situation in the Inter-Mountain area and report as early as practicable in order that a decision may be reached by the Executive Committee on the exact time and location of the 1950 meeting.

20. The Executive Committee of the Eastern Branch, consisting of Nelson, Gould and Packard, discussed the matter of paid publication of the Eastern Branch, the general status of Branches and the plans of the Eastern Branch for the publication of *Entoma*.

The Committee recommends the discontinuance of all present or prior arrangements regarding the publication of Eastern Branch papers and payment therefor. It recommends that all Branches be placed on an equal footing with regard to publication. The Executive Committee expressed its willingness to accept full responsibility for the publication of *Entoma* subsequent to the eighth volume, if the Eastern Branch is willing to relinquish its right thereto and turn over *Entoma* to the Parent Association.

21. The report of the special committee on Medical Entomology consisting of A. D. Hess, *Chairman*, H. H. Stage, F. W. Whittemore, Jr., John D. De-

Coursey and M. A. Stewart was accepted, ordered published and the committee discharged with thanks. The Committee concluded that it was not desirable to appoint a standing committee on Medical Entomology.

22. Messrs. Simmons and Reed presented a charter for the Section of Medical Entomology. This was slightly altered in verbiage and accepted. It is to be ratified by the Section and announced to the Parent Association.

23. The Committee recommends:

1. The discontinuance of the following standing committees with thanks for the efficient conduct of their work. These recommendations are based upon the belief that the need for the committees enumerated no longer exists, but the Committee wishes to stress the desirability of regional and special subject matter conferences:

a. Committee on the Codling Moth
b. Popular Entomological Education
c. Committee on Cooperation with Pest Control Operators
d. Committee on Relation of Entomology to Conservation
e. Committee on Grasshopper Research

24. The Committee recommends the discontinuance of affiliation with the Crop Protection Institute owing to pending changes in the governance of that Institute.

25. Since the Union of Biological Societies was discontinued during this year, no representation of this Association is required.

26. (1) Report of the Committee on Common Names was accepted. (2) Report of the Committee on Insecticide Terminology was accepted. (3) Report of the Committee on Codling Moth was accepted and the committee discharged. (4) Report of the Committee on Grasshopper Research was accepted and the committee discharged.

27. The recommendation for the preparation of a business meeting agenda which shall preclude the consideration of any other business was not accepted due to the impracticability of the proposal.

28. The limitation of symposia to two at the annual meeting with all the rest of the time devoted to paper reading sessions was not accepted.

REPORT OF THE COMMITTEE ON COMMON NAMES OF INSECTS

During the year the Committee adopted common names for two insects not previously included in the official list of common names and changed the approved name for one other insect. A report of this action was published in the February 1948 issue of the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 41, No. 1, p. 47). A proposal that one of the names adopted during the year by the Committee be changed failed to receive the necessary approval of seven committee members. As of December 6, 1948, the Committee had on hand 60 proposals for additions to the official list of common names, and 14 proposals for changes in approved names. A study has been made of these proposals and, in a number of instances, sufficient information is at hand to warrant an early vote by the committee members.

Our attention has been directed to the fact that certain interested groups have gone on record as expressing dissatisfaction with the action taken by the Association at the annual meeting in Chicago last, whereby this Committee was authorized to select and adopt common names for insects on behalf of the Association. The Committee is of the opinion that the change in procedure was highly desirable. Past experience has shown the former method of referring ballots to the entire membership of the Association to be unsatisfactory. Although members were cautioned not to vote for names in which they were not especially interested, enough of them did so to make the former procedure undesirable. Experience during the year with the new procedure indicates, however, the desirability of providing the membership of the Association as a whole an opportunity to register objection to any proposed common name prior to its official adoption. The Committee, therefore, proposes that the nine members continue to adopt a common name for any insect or group of insects upon agreement of at least seven members, but that at least thirty days prior to such action the entire membership of the Association be advised of each name being considered for adoption. Such notification might be accomplished by publishing a list of the proposals in the JOURNAL OF ECONOMIC ENTOMOLOGY. It would then be the responsibility of the membership of the Association to advise the chairman of this Committee promptly in the event of an objection to any proposed name under consideration.

H. M. HARRIS — E. G. LINSLEY
F. W. POOS — C. F. W. MUESEBECK
C. E. PEMBERTON — R. K. FLETCHER
A. V. MITCHENER — ARCHIE N. TISSOT
G. J. HAEUSSLER, *Chairman*

President Rohwer: I think that the Statement from the Executive Committee tells you some of the things of which we are thinking. I think that you as members of the Association may have some comments on it. Does anyone wish to comment on it in advance of the motion to approve or disapprove the recommendation?

R. A. Parker: Does that mean that we are doing away with the exchange of research which is what the function of the Grasshopper Research Committee used to be?

Pres. Rohwer: No. We as the Executive Committee feel that there are still ways to do it. We feel that these specialized committees and the benefits from those specialized committees can be implemented in another way. We either have to have more committees on special subjects like corn borer, aphids, tropical insects, cotton insects, or put ourselves on a basis of stream-lining somewhat the affairs of the Association. We feel there will be adequate opportunity for those types of procedures without the committees, and that our committees have to be too specialized and not all-inclusive.

Mr. Parker: That answers my question, but I still think it is a rather sudden move to eliminate a committee which has been functioning for a number of years without consulting the members of the committee. I feel we have had need of the program in the past and I hate to see it suddenly terminated. But if it is the feeling of the Executive Committee that we can still carry this on as a group by ourselves, I'll say no more at this time.

Pres. Rohwer: I don't think, Bob, you will lose anything by this action, but I think the Association will gain. Any other comments?

Mr. Glen, Canada: Our Canadian representative on the Grasshopper Research Committee is not present. I, therefore, take the liberty of speaking

spontaneously on his behalf. I would like to make this point: Could it be left to the committee to comment when possible on the recommendation that is before the house. In other words, if this is passed, could that be brought to the committee for their consideration. I would like to agree with Mr. Parker, that it is a rather sudden way to terminate the action of a committee which has been beneficial.

Pres. Rohwer: Thank you. We have Standing Committees and they are elected by the Association. We regret there was no opportunity for consultation but we either would have to elect new members, new chairmen, for those committees and continue them, or take a rather drastic step. We felt that in the interest of uniformity, without the committee which specialized on one particular subject and neglected some other there would be adequate opportunity for those things to be handled that Dr. Parker referred to. There will be no reason why a group cannot present to the Resolutions Committee or at the business session, anything pertinent to a special subject.

Mr. Glen: I take it then that the trend in general will be away from special committees.

Pres. Rohwer: That's right. Any other comments?

Mr. L. M. Peairs: I think perhaps a little explanation of the reasons in the minds of some of the members of the Executive Committee for this action might be in order. I speak only for myself and am not endeavoring to speak for the members of the committee, but I think the Grasshopper Research Committee is one which might most nearly be justified in having any objection to it in principle. For 24 years, we have had, in a couple of States here in the East, a conference on fruit problems. That conference has included entomologists, pathologists, horticulturists, and they have had annual meetings. They discuss the problems, the overlapping problems, and including horticultural problems. They do it in a manner that has proved very effective and satisfactory for that reason. I know that there are other regional conferences which work in much the same way and I believe that method of attack is more effective, more justified, than the continuing committees of the Association. In addition to that, we are increasing the number of our Sections. Possibly the Codling Moth Committee found it difficult to harmonize the eastern conditions with the Pacific Northwest. A separate conference in the Pacific Northwest would probably accomplish more for that area than the over-all standing committee of the Association. It was things like that which made us favor abolishing the various committees.

Dr. Frank Campbell: I had a little experience with the Popular Education Committee as editor of the Scientific Monthly. I wanted very much to help publicize the work of entomologists and I wanted one or more representatives appointed by this Association to provide a periodic short series of articles on advances in economic entomology for the Scientific Monthly. I am sorry to say nothing happened. I think that would have been an excellent function for the committee on Popular Entomological Education to provide me with the information desired and to do that same thing whenever opportunities arose. But the Committee apparently has not been functioning well. Now I simply want to raise the question, "What are we going to do about it?" What arrangements can be made to replace that committee so that we will get good functions in Popular Entomological Education? I would like Mr. Rohwer to comment on that particular thing. I think we need in this Association some one person or group of persons who would take that matter to heart and who will continually endeavor to spread the good word. Dr. Rohwer considers the entomologists have been a little backward about advertising their wares. Let us do something about it.

Pres. Rohwer: Thank you Dr. Campbell. We thought about that. Continuing committees become just what they always are. There are years and there are times when you can't do very much. The job you referred to probably could be better pointed out through a special committee. We elect our committees. There is not always the opportunity by our method of election to select those people who can do jobs of a special interest most effectively. There will be no reason why the Executive Committee cannot approve—or the President himself cannot announce the appointment of—special committees to do special jobs, and in do soing he will probably weigh carefully the particular jobs in the particular selection.

Pres. Rohwer: I would like to entertain a motion to see whether you agree or disagree with the action recommended by the Executive Committee.

Motion was made by Harry Dietz, seconded by Clay Lyle; Motion carried without objection.

Conclusion:

Pres. Rohwer: The next business session will be the Report of Special Committees on Thursday at 9 A.M. (December 16, 1948)—Final Business Session. Meeting adjourned at 12 noon.

REPORT OF THE COMMITTEE ON INSECTICIDE TERMINOLOGY

During 1948, your Committee has given further consideration to the proposal and establishment of common names for insecticides that are known only by long, unwieldy chemical designations or by trademarked names. These activities have been concerned chiefly with policies and procedures in the naming of such insecticides and with the kinds of names that are suitable for them. Some progress has been made in the selection of names for four insecticides.

At least four governmental agencies and as many non-governmental agencies, including this Association, have an interest in common names of insecticides. In addition, each industry is interested in any name that may be established for one of its products. Of the governmental agencies, the Interdepartmental Committee on Pest Control has taken the lead in getting approval of common names of insecticides from interested agencies and industrial groups.

A consideration of these activities shows that the naming of an insecticide is at present a complicated process, involving extended correspondence with many persons. No single agency has been established which can approve common names of insecticides for general public use. Early this year, the Interdepartmental Committee on Pest Control met with representatives of various agencies in Chicago to review various questions, and work out procedures that might be followed in selecting and establishing common names for pest-control chemicals. H. L. Haller represented your Committee at this meeting. After a thorough-going discussion various proposals were made looking toward unification and concentration of effort The entire matter is still under consideration.

Your Committee has given its approval to a name for an important new insecticide which has been

under consideration by the Interdepartmental Committee for some months. Further work must be done by this Committee before the name is ready for official approval.

Consideration was also given to the proposal of names for three established insecticides of known chemical structure. Progress has been made in Committee, but names are not yet ready for consideration by other agencies.

Your Committee recommends continuing cooperation with other associations and agencies in the matter of establishing common names for insecticides.

GLENN F. CARMAN J. R. EYER
H. L. HALLER H. H. SHEPARD
C. H. RICHARDSON, *Chairman*

REPORT OF THE COMMITTEE ON THE CODLING MOTH

At the request of your Committee the Bureau of Entomology and Plant Quarantine will assemble and distribute the results of codling moth research in 1948. This pool of information will constitute the fifteenth consecutive annual compilation. The Bureau has invited the codling moth workers to submit reports of the past season's work on codling moth and the associated problems arising from the use of DDT or from changes in long established control programs.

Opinion as to the need for another codling moth conference this winter was divided, consequently no conference has been scheduled.

This Committee has in the past suggested lines of research considered most needful of additional attention. These suggestions may be referred to in the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 35, p. 134, 1942; Vol. 36, pp. 170–1, 1943; Vol. 37, pp. 174–5, 1944; Vol. 41, pp. 136–7, 1948).

In addition your committee suggests that as newer, more powerful insecticides than DDT are introduced investigators who test them over a period of years pay particular attention to their effects on pollinating insects, particularly the honey bee, on fruit production and quality, on the keeping quality of fruit in storage, and on the long-time effect of spray residues on the soil. Most of these effects may vary greatly under different cultural practices, climatic conditions or soil types. Likewise the addition of new insecticides to the DDT codling moth spray program on an orchard-wide scale for the control of specific pests may further upset natural checks and lead to serious losses from unanticipated outbreaks of minor pests, unless these possibilities are adequately investigated before the new materials are suggested for grower usage. It is quite probable that many of the new insecticides will prove incompatible with the fungicides, either old or new, that might be needed to control fruit diseases. This incompatibility may be physical as well as chemical, so that the amount deposited, its resistance to weathering, its distribution, or the toxicity of either the insecticide or fungicide may be adversely affected by the introduction of the new material to the spray program. Insect control must be balanced into the whole program—production, marketing, and use and the investigator must not underestimate his great responsibility toward each of these phases.

Your committee reiterates the suggestion made a year ago that the Association and its Executive Committee consider the advisability of discontinuing the Committee on the Codling Moth or of changing its name and broadening its scope.

The development of DDT for codling moth has reduced this control problem to one of much less importance. The problems which have arisen because of the toxicity of DDT to many parasites and predators, or because of the displacement of long-used insecticides in the spray program, or the use of new types of insecticide application equipment have lessened the need for emphasis on codling moth control and transferred it to many different associated problems which vary greatly in the various fruit growing sections. For example, it has become necessary in various sections of this country where DDT has been used for codling moth control to develop more effective means of controlling at least 7 different species of orchard mites, the red-banded leaf roller, and the wooly apple aphid, as well as San Jose and Forbes scale. Parathion and other newer and more powerful insecticides than DDT may scatter the emphasis on the codling moth still further.

If it is the wish of the association to continue this Committee under a new name your present committee suggests as a possible title, "Committee on Insects Affecting Pome Fruit Production." For the new scope of this Committee it is proposed that its work be directed toward the more economical and effective control of all insect pests attacking pome fruits either directly or as vectors of disease and with the maximum possible conservation of beneficial insects, both natural-enemy and pollinating types. This work should give full consideration to the fruit grower's other production and marketing problems as well as the consumers interest in quality and avoidance of harmful (or otherwise objectionable) residue.

At the Association's 1947 meetings, the Section on Insecticides voted to request this Committee to set up minimum standards for the preliminary field testing of codling moth insecticides. The membership of your Committee is divided in its opinion of the need for such required standards. It is recognized that facilities and pressure from other work might keep some investigators from following prescribed standards, or local conditions might make their use disadvantageous. However, the investigator who publishes his results has a distinct obligation to others, an obligation that has too often been ignored in the past. He should not fail to give a clear explanation of the procedures used, and the safeguards taken to insure adequate and reliable sampling so that the reader can properly judge the value of the work and decide with a reasonable degree of accuracy as to whether the material is worth his consideration. Several suggestions for testing technique are appended to this report. These are intended as a guide for investigators wishing information, not as a necessary requirement for setting up codling moth insecticide tests.

P. J. CHAPMAN J. H. NEWTON
DWIGHT ISLEY W. J. O'NEILL
G. E. MARSHALL L. F. STEINER, *Chairman*

APPENDIX TO THE REPORT OF COMMITTEE ON THE CODLING MOTH December 13, 1948

Suggested Standards for the Preliminary Field Testing of New Codling Moth Insecticides

These suggestions are for the intermediate step in the development of a new insecticide, after laboratory or single-tree tests have shown it to have some promise and to be relatively non-injurious to fruit

or foliage. This step should precede large-plot or orchard-wide tests.

Size of replicate. Each replicate may consist of one or more trees. The trees used for record purposes should be as uniform as possible with respect to crop and size. Replicates larger than single trees are desirable if the effects on mites or leaf rollers are also to be studied.

Number of Replicates. Four are considered the minimum necessary, but the use of 5 to 7 will greatly increase the value of the experiment and generally narrow the differences required for significance. Replicates should be set up in a restricted randomization, that is, all treatments should appear in a random distribution and in the closest possible proximity with each replication.

Number of treatments. Results will become less reliable as the number of treatments exceed the number of replications. Usually 2 or 3 times as many treatments as replications can be safely tested in a single set up.

Taking results. Different insecticides are likely to vary in their suspceptibility to decomposition, to weathering from wind and rain, and in the amount of redeposition of residues in various parts of the tree. Because of this it is imperative that results be taken that will represent the whole crop. Usually the investigator can obtain reliable estimates by examining a portion (200 to 300 apples when available) of each drop collection and each harvest picking. The total number of fruit, as well as injuries, represented by each sample must be determined so that whole-tree estimates can be properly computed.

Interplot movement of moths and differences in the toxicity of sprays and spray deposits to moths reduce the reliability of small-plot tests when they extend beyond the active period of one generation, therefore, in two- and three-brood areas where most of the sprays are often applied during the first-brood hatching period, separate estimates of treatment performance against the first generation, and if possible the second, are essential if the investigator desires to forecast the probable comparative performance of the test materials in large-scale use. On-the-tree examinations of stratified samples (all parts of the tree proportionately represented) at the end of first-brood attack will yield information that will be of considerable value in analyzing the final results.

Presentation of results. If yields are not uniform infestation intensity and volume will both be affected by the differences. Yields should be given, along with the number of injuries per tree and either the per cent of fruit affected or the number of injuries per fruit or 100 fruits. When yields differ the per cent of fruit injured may sometimes be the same yet the number of injuries per tree may vary significantly, likewise equal tree populations may be associated with significant differences in per cent of fruit injured.

Other factors such as uniformity of spray applications, accuracy of measurements, differences in meteorological conditions when various treatments are applied, in sources of reinfestations, etc. are also the responsibility of the investigator to consider, record, and properly evaluate when he reports his results.

Many workers will want to go further than outlined above in improving the reliability of their work and in assisting others in properly interpreting the results.

COMMITTEE ON THE CODLING MOTH, 1948

REPORT OF THE COMMITTEE ON GRASSHOPPER RESEARCH

It is indeed unfortunate that it was not possible to hold a meeting of the committee this year, and it is suggested that in the future all members who are present at the annual meeting of the American Association of Economic Entomologists get together for at least a brief discussion on policies and plans. At the meeting in St. Paul, Minnesota, in March 1947 (see report of committee, JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 41, No. 1, p. 136) certain recommendations were made. It is felt that these recommendations, particularly the appointment of a permanent secretary, should be implemented. Unfortunately, Dr. C. E. Mickel, of the University of Minnesota, who was appointed to interview commercial organizations which might subscribe funds for such a man, found it necessary to drop this assignment

It is recommended that someone be appointed in Dr. Mickel's place to explore the possibility of securing financial assistance to establish a position of permanent secretary.

Arrangements have been made for assembling the annual confidential report on grasshopper research conducted in the United States and Canada.

D. A. WILBUR — R. H. HANDFORD
J. R. PARKER *ex officio* — SAM MCCAMPBELL
CLAUDE WAKELAND *ex officio* — EPHRIAM HIXON
H. L. SEAMANS, *Chairman*

REPORT OF THE PUBLICATIONS COMMITTEE

1. Recognizing that the policies and rules that govern the preparation and publication of articles for the JOURNAL are scattered through the various committee reports and Association resolutions published over several years, making such matter difficult to find and often difficult to interpret, the committee will in the near future, bring together for publication in one body such policies and rules. It is proposed that this matter be also published as a separate for distribution to new members as they come into the Association.

2. The Committee recommends that the Associate Editor shall be Ex Officio, a member of the Publications Committee as well as a member of the Editorial Board, as is already provided by rule.

3. Recognizing the need for a usable name for each insecticidal material as soon as it is released for experimental use, and as soon as the manufacturer has stated its chemical composition, we request that the Committee on Insecticide Terminology consider adoption of a temporary designation, preferably a combination of letters and numbers for the new material, until such time as the Committee assigns an official common name. The Publications Committee reaffirms the recommendation of the Committee on Insecticide Terminology (JOURNAL OF ECONOMIC ENTOMOLOGY, 40: 156) that trade marked names for insecticides be placed in footnotes, once in each article, below the common name as used in the text.

T. L. BISSELL (acting for F. S. ARANT)
R. W. DEAN
W. H. WHITE
W. E. DOVE
J. A. MUNRO

REPORT OF THE COMMITTEE ON RELATION OF ENTOMOLOGY TO CONSERVATION

The presentation of this committee will be a departure from those of the past, in that it is actually a report on a self-inspection.

Several members have expressed themselves along similar lines, and excerpts of these expressions will point up the recommendations to follow. One member has this to say:

"Even though I have reviewed all of the past reports of this committee, I am not clear as to the scope and duties of the committee. The term 'conservation' covers a large field. Actually, all of our applied entomology is conservation. Conservation of our forest resources involves protection from insects. Except for the element of time, protection of forests from insects is not basically different from protection of other crops."

Another expresses his views in a like vein:

"The terms of reference of this committee published in Volume 38 of the JOURNAL appear to me to be very vague, and from them it does not seem to be clear just what the association had in mind. It might be of value to have the functions of the committee clarified, for instance, in what is meant by the term 'conservation,' which covers a very wide field indeed."

A third has the following comment:

"By the time I had completed serving my previous term, I had seriously begun to doubt that a committee such as our is in a position to take any definite concrete action to forward the cause. Therefore, about the only course left is to write up a report, pointing out some entomological problems related to conservation.

"Up to the present time, I doubt that this committee has pointed out any items that had not previously been recognized, and not only recognized but a start had already been made to obtain further information concerning it."

The history of, and instructions to, the committee are found in the JOURNAL (38 (4): 514) and are reproduced herewith:

"As insect problems are co-extensive with and inseparable from conservation problems; as the interrelation of such problems has had scant consideration; as conservation programs must be adjusted and readjusted from time to time to conform with specific knowledge; as there is an urgent need for a more general understanding and for planned coordination in the relation of entomology to conservation—a continuing agency of the American Association of Economic Entomologists should act as a fact finding body to advise the Association concerning general policies and particular problems and to cultivate cooperative relations with similar agencies if and when created by other organizations concerned."

It appears that the instructions to the committee are general, and that the reports to date are in general phraseology.

If a committee such as this is to be specific it should have its duties and limitations specifically outlined. It is possible that the term "conservation" has taken on a wider connotation since the committee was formed; it is also possible that emphasis has changed since its conception. But it is equally possible that there has never been a greater need for coordination of all interrelated agencies in activities falling in the field of conservation. Entomologists have been critical of the activities of some conservation agencies for their lack of a broad picture, and these agencies have, possibly with equal merit, been critical of some entomological programs.

Reports of this committee have, in the past, dealt with general conservation problems, as we have said, in somewhat general terms. What have been the accrued values? Certainly committee contributions should have been the mature views of capable members, and as such may have pointed up thinking in the profession and possibly stimulated some voluntary action. Many of these reports actually have been in the nature of well prepared editorials, the function of which should be to stimulate thought and, through it, action. At times they have of necessity smacked a little of the platitudinal. There is a place for such recorded thought, and the reports as published in the JOURNAL fill a need.

But year after year of this reporting should culminate in some tangible, measurable activity. Has it? That is the question in the minds of your committee.

We feel that specific action by this committee is more difficult to attain, in the light of its present instruction, than in the case of such committees as those on membership, terminology, etc.

We therefore respectfully suggest that the Association decide

1. What is meant by "conservation"; what are the limits implied.

2. Whether or not the committee should continue as of the past in mirroring conservation entomology thought for guidance of the profession; or

3. Whether or not it should be emphasized that future committees will have concrete action to take and proposals to present to the Association. Such action could be in the form of (a) analyses of what conservation measures entomologists are taking either directly or in cooperation with agencies, (c) the establishment of a council of conservation and related groups for periodical examination of activities involving cooperative action, (d) the periodical notification of members (through the JOURNAL?) of new conservation activities where entomological assistance is desirable, (e) the research, or the reviewing of progress of a cooperative nature.

In summary, should the committee editorialize or should it have specific tasks to accomplish or at least to attack?

The committee feels that there is a place for activities along all of the lines mentioned herein. It feels that the work of future committees will be greatly facilitated if the Association either endorses past committee actions or crystallizes a more active program for the future.

Respectfully submitted,
R. D. GLASGOW
C. R. TWINN
F. E. WHITEHEAD
N. D. WYGANT
H. B. MILLS, *Chairman*

REPORT OF THE JOINT COMMITTEE ON THE PREPARATION OF A HISTORY OF ENTOMOLOGY IN RELATION TO WORLD WAR II

1. The American Association of Economic Entomologists and the Entomological Society of America, at heir final business meetings at the annual meeting in Chicago, Illinois in December 1947, and through subsequent action of their respective executive committees, authorized (a) the continuation of

the Joint Committee on the Preparation of a History of Entomology in Relation to World War II, (b) the appointment of Col. E. C. Cushing as general editor, and (c) the expenditure of not to exceed $1,000.00* for the services of the editor and other necessary expenses in connection with the preparation of this History.

2. (a) During the past year the Committee has continued its efforts to assemble material of value in the preparation of reports, these efforts for the most part being directed toward obtaining more complete information from the sources mentioned in the report presented at the last annual meeting.

(b) The necessary arrangements regarding the preparation of the History have been made with Col. Cushing and he has been engaged for some months on the project as time permitted. Since November 17 Col. Cushing has been on active duty with the Army in the Office of the Surgeon General, on a tour of duty of three months. This assignment affords Col. Cushing the opportunity to make the very necessary contacts with numerous federal agencies that are believed so necessary to this project, and gives him access to the many and voluminous reports which must be reviewed and abstracted in the course of this work. The Committee feels that this arrangement is most fortunate since it permits our editor to acquire a wealth of information not otherwise obtainable, and has enabled him to make excellent progress on the History since this arrangement has been in effect.

(c) The arrangements with the general editor mentioned in (b) above were delayed until almost mid-year due to circumstances beyond the control of this Committee, and the actual work of writing the History was not begun for some time thereafter. Nevertheless, the General Editor and the Committee hope and believe that the manuscript of this History will be in final form for consideration by the executive committees of the two societies at the next annual meeting. No recommendations for further action concerning the manuscript will be made until it is available in final form.

(d) In view of the very promising progress that has been made by our Editor it is recommended that a Joint Committee of four members, two from each Society, be appointed to assist in an advisory capacity for the duration of this project.

(3) No expenditures have been made by the Committee during the past year.

RALPH W. BUNN — STANLEY W. BROMLEY
EDWARD F. KNIPLING — P. W. OMAN
Co-Chairman — *Chairman*

REPORT OF THE COUNCILLORS FOR THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Your councillors were represented at the meeting of the Council on Monday, September 13, at 3 P.M. at the Statler Hotel, Washington, D. C. The items of business at the Council meeting were as follows:

1. The President announced the appointment by the Executive Committee of Dr. Howard A. Meyerhoff of Smith College as Administrative Secretary to succeed Dr. F. R. Moulton for a term of four years, beginning January 15th, 1949.

2. The Administrative Secretary presented and discussed matters pertaining to the financial status of the Association.

3. The President asked for nominations for President and five names were proposed from the floor. In addition, it was moved, seconded and voted that additional nominations be solicited by mail in the usual manner from members of the Council and that the nominations from the floor be listed in the request mailed to the Council.

4. It was moved, seconded, and voted that nominations for Vice-Presidents, one from each of the 15 sections of the Association, be made in the customary manner by the individual sections.

5. Upon motion it was voted that the General Secretary be authorized to appoint a committee to study and recommend standards or qualifications upon which societies may be considered for admission as associated or affiliated societies of the Association.

6. It was voted that the Executive Committee appoint a committee of three to seven members to consider and report on organizing or establishing local chapters of the Association.

7. The question was raised on methods of starring scientists in the American Men of Science. The question of electing members to Fellowship in the Association was also discussed. It was voted that with the ballots sent to the Council for the election of President and Vice Presidents of the Association, the members of the Council be asked also to vote on these two questions.

8. It was further voted that the Council be asked to ballot on the type of meeting which the Association should plan following the New York meeting in December, 1949. Specifically, the question involves (a) returning to the standard type of meeting, (b) adopting the conference type of meeting, without provision for specialized activities of sections and affiliated societies, and (c) alternating the two types of meetings.

9. Dr. Shapley reported that the committee on freedom in science was to discuss the problem at the Executive Committee meeting on Wednesday, September 15.

10. Following a report by Dr. Mather, it was voted that the Executive Committee be authorized to investigate the possibilities and to follow developments in connection with the proposed International Federation of Associations for the Advancement of Science and to report at the next meeting of the Council.

11. The Council received an informal report by Dr. Parks on the Gordon Research Conferences at New London, New Hampshire.

ROGER C. SMITH
BAILEY B. PEPPER

REPORT OF THE REPRESENTATIVE TO THE DIVISION OF BIOLOGY AND AGRICULTURE OF THE NATIONAL RESEARCH COUNCIL, 1948

The annual meeting of the Division of Biology and Agriculture was held in Washington, D. C., on May 6, 1948, under the chairmanship of Dr. J. S. Nicholas. The following items reported to or acted upon by the membership will be of some interest to entomologists:

1. The American Institute of Biological Sciences was formally established within the framework of the Division on February 20, 1948, with 12 societies

* $750.00 from the AAEE and $250.00 from the ESA.

accepting full membership and one society adhering as an affiliated member. No entomological group has become a member of the Institute.

2. Two societies, the American Association of Anatomists and the Biometric Society, were accepted as members of the Division of Biology and Agriculture.

3. In the general field of conservation, efforts are being made to reconstitute the Committee on the Ecology of Grasslands, under the chairmanship of Dr. Shelford.

4. Two fellowships to support research in the field of entomology were awarded by the National Research Council on the basis of recommendations of the Division's Committee on Fellowships.

The National Research Council is a cooperative organization of the scientists of America, responsible for many of the contacts which are made between scientific societies. The ramifications of its influence are very broad, yet its activities are too little appreciated. The Council comprises eight major divisions of which the Division of Biology and Agriculture is the one with which entomologists are concerned. Affiliated with the Executive Committee of the Council is:

1. The Pacific Science Board, one of whose committees is the Insect Control Committee for Micronesia, and

2. The Chemical-Biological Coordination Center with its Entomological Subcommittee. In addition to the latter, two entomologists are members of the Coordination Center's Biological Codification Panel.

Your representative has been called upon by the division of Biology and Agriculture to furnish information regarding such matters as entomological meetings and attendance of entomologists at the International Congresses of last summer. He would appreciate suggestions as to how the National Research Council, through the affiliated societies may assist entomologists more effectively in their research and operations.

Respectfully submitted,
HAROLD H. SHEPARD

ANNUAL REPORT OF AMERICAN COMMITTEE ON ENTOMOLOGICAL NOMENCLATURE

The outstanding nomenclatural event in 1948 was the meeting of International Commission on Zoological Nomenclature in connection with the Thirteenth International Congress of Zoology in Paris. Notice of some of the most important decisions taken at this meeting has been published in *Science* and elsewhere. In anticipation of this meeting of the Commission, the American Committee on Entomological Nomenclature studied some of the pending cases for which the Commission had published advance notice of applications. The results of this study were communicated to the Commission. In addition, the Committee prepared two applications of its own and submitted them to the Commission. The first of these involved the status of names given to forms of less than subspecific rank. The second petition related to generic names published after December 31, 1930, without definite unambiguous designation of the type species. Following the Paris meeting, the Secretary of the International Commission notified the Committee that these matters were considered by the Commission and decisions reached on the various phases of these two problems which had been included in the petitions.

Members were elected or re-elected for 3-year terms to fill vacancies in the Committee as follows: M. A. Cazier, C. W. Sabrosky, E. G. Linsley.

Officers elected for the year 1949 are E. G. Linsley, *Chairman*, and C. D. Michener, *Secretary*.

Respectfully submitted,
E. G. LINSLEY, *Secretary*

THE CROP PROTECTION INSTITUTE

The activities of the Institute in 1948 have included research in the following fields:

A spreader sticker that does not interfere with insecticidal or fungicidal activities.

A comprehensive investigation of fatty acid derivatives.

The influence of various types of inerts on insecticidal dusts.

Formulae for aerosols.

Development of a mothproofer that will withstand washing and dry cleaning.

Terpene derivatives.

Extracts of derris root.

A new cuprous oxide.

Chemotherapy, especially as related to Dutch elm disease.

Dithiocarbamates.

The incorporation of DDT in paints.

Reinforced oil sprays for home gardens.

Companies supporting the principal programs of research included the following:

Armour & Company
Attapulgus Clay Company
J. T. Baker Chemical Company
Boliden Mining Company
Bridgeport Brass Company
Davison Chemical Corporation
Ethyl Corporation
General Chemical Company
Hercules Powder Company
Johns-Manville Corporation
The Mathieson Chemical Corporation
Niagara Sprayer and Chemical Company
S. B. Penick & Company
H. H. Robertson Company
Rohm & Haas Company
Sunoco Products Company
Standard Oil Company (Indiana)

Changes are under study in the procedure through which the Board of Governors of the Institute is selected. These are not completed but include the following:

Enlargement of the Board so that it may represent one or more additional fundamental sciences such as soil chemistry and microbiology.

A new procedure for selecting personnel for the Board. It has long been apparent that members of the Board represent certain fundamental sciences rather than certain professional societies, such as the American Phytopathological Society and the American Association of Economic Entomologists. Since the Institute is an independent body, confusion sometimes arises from the fact that entomologists of the board have had the status of a standing committee of the American Association of Economic Entomologists whereas the Associaion does not in itself direct the activities of the Institute. A proposed change would eliminate this confusion. Entomologists will be selected by an appropriate procedure but will not constitute a standing committee of the Association, named by a nominating committee as are officers of the Association. The enlarged Board

will probably include 10 or possibly 12 men and will represent the sciences of entomology, plant pathology, plant chemistry, and probably soil chemistry, and bacteriology.

Beginning in 1948 the Institute enlarged its scope by providing for an advisory service to such manufacturers of insecticides, fungicides, and other materials as may wish to avail itself of the Institute's broad knowledge and experience.

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES—REPORT OF OBSERVER

At the request of the President, Dr. S. A. Rohwer, I served as an observer at the meetings of the Governing Board of the American Institute of Biological Sciences. One meeting was held February 20, 1948 and a second on September 13, both at the National Academy of Sciences at Washington. The Institute was formally organized on February 20, a sufficient number of societies having substantially met the requirements.

The Institute has adopted the following revised basis for the determination of the dues of member societies: $1.00 per year for each member belonging to but one society having full membership in the Institute, and $0.50 for each member belonging to two or more such societies, up to a maximum of $1,000. With a society with 2,000 or more members, as in the case of our Association, the reduction for overlapping membership is of no significance, since the dues would be the maximum figure anyway.

The Institute made arrangements for meetings held by a number of societies in biological sciences in Washington during September, at the time of the meeting of the American Association for the Advancement of Science, and is prepared to make similar arrangements in the future if desirable.

Shortly after the September meeting, Dr. Milton Lee was appointed Executive Secretary for the Institute. He is serving on a part-time basis.

A number of activities are contemplated by the Institute. One of these projects is the preparation and publication of a handbook of biological facts. In the interest of economy and efficiency, consideration is also being given to arrangements for joint contracts covering the printing of publications of various member societies. As far as I know, these projects are still in the developmental stages.

B. A. PORTER

REPORT OF THE SECTION OF AGRICULTURE

The Section of Agriculture met in Parlor A., New Yorker Hotel at 1:30 December 13, 1948. In the absence of the Chairman Dr. E. J. Dyce who was attending an apicultural meeting in St. Louis, Dr. E. F Phillips presided and read the Chairman's address. In addition to this five papers were presented. Of these, four were concerned with the subject of bee poisoning which proved to be the focus of much interesting discussion.

In the business session a motion was made, seconded and passed, that the address of Chairman Dyce be mimeographed and distributed to interested parties, particularly to experiment station directors, to extension entomologists and to beekeeper's associations: Dr. Dyce to be consulted regarding the advisability of recasting the paper to suit the various audiences.

The nominating committee presented and the voting members elected for Chairman and Secretary respectively,

EVERETT OERTEL and W. A. PRICE

Fifty-five persons attended the meeting, which was in continuous session until 5 P.M. when it was adjourned.

W. A. PRICE, *Secretary*

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee on Membership has considered the applications for active membership submitted by 135 persons. The data in the applications have been summarized by the Committee Charman and submitted by mail to committee members. A recorded vote is cast by committee members for or against each applicant. Applications in due form, properly certified and accompanied by the required fees have been acted upon at approximately monthly intervals. A few applications have required several months for processing. Applicants that have been unanimously approved for membership in the Association total 134. One application has been withdrawn. Eighty of these applicants were approved for membership before September 1, and their membership dates from January 1, 1948; 54 were approved after September 1 and their membership becomes effective on January 1, 1949. A list of the new members follows:

List of new members effective January 1, 1948

Allen, R. P.
Baker, J. A.
Barron, I. R.
Burcham, E. G.
Burge, L. M.
Charpentier, L. J.
Connelly, R. B.
Corry, A.
Coyne, S. J.
DeFoliart, G. R.
Denning, D. G.
Dodd, F. O.
Duzgunes, Z. U.
Eads, C. O.
Evans, A. W.
Evans, R. E.
Ferguson, P.
Field, G.
Fletcher, O. K.
Frost, M. H., Jr.
Fullmer, O. H.
Gallaway, O. H.
Gast, R. T.
Gates, F. H.
Ghani, M. H.
Hall, D. E.
Hanna, R. L.
Hayslip, N. C.
Hoffman, R. A.
Iglinsky, W.
James, M. T.
Jett, J. A.
Johansen, C. A.
Kellogg, W.
Lancaster, F. R.
Lowry, W. E.
Lund, R. H.
Lung, P. H.
Lynch, J. H.
Lyness, R. N.
Madsen, H. F.
Maehler, K. L.
Maina, B. A.
Moreno, I.
Morgan, B. B.
Mowry, P.
Mueller, P. W.
Murphy, U. E.
Owen, F. E.
Owens, V. H.
Pagán, C.
Pielou, D. P.
Pimental, D.
Pratt, H. D.
Radeleff, R. D.
Rao, V. P.
Revell, I. L.
Roder, E. V.
Roth, E. N.
Rueger, Myrtle E.
Saha, J. S.
Seaman, R. V.
Sloan, M. J.
Smith, J. N.
Solomon, E. L.
Stevens, J. E.
Stewart, A. W.
Strew, S. W.
Stultz, H. T.
Summers, T. E.
Sylvester, E. S.
Taylor, R. E.
Tunis, W. A.
Walstrom, R. J.
Williams, H. M.
Wilson, I. B.
Wolf, M. A.
Woodworth, R.
Young, B. J.
Young, E. G.

List of new members effective January 1, 1949

Allen, W. R.	Johnson, A. W.
Back, R. C.	Kane, N. F.
Bailey, S. E.	Kohler, C. E.
Barr, W. F.	Loden, H. D.
Batchelor, G. S.	Lomax, J. W.
Benjamin, D. M.	McClurkin, J. I., Jr.
Bickerton, J. M.	Mc Kenna, J. P.
Bixby, A. F.	Messenger, A. P.
Bohart, G. E.	Michael, J. E., Jr.
Boush, G. M.	Midlam, C. E.
Carlson, A. E.	Nelson, J. A.
Clark, P. H.	Northwood, A. F.
Coarsey, J. M., Jr.	O'Brien, W. J.
Coe, L. E.	Poland, J. L.
Corliss, J. M.	Pratt, B. G., Jr.
Coyne, J. F.	Reynolds, D. J.
Cunliffe	Rossi, L. E.
Dobson, R. C.	Scoggin, J. K.
Farr, T. H.	Seeley, A. L.
Foster, J. R.	Smallman, B. N.
Frank, M. S.	Soliman, A. A.
Franklin, W. W.	Summers, F. M.
Frick, K. E.	Van Skike, K. R.
Griggs, C. B.	Watwood, R. P.
Haberman, W. O.	Wilkes, A.
Hinman, E. H.	Wolfe, H. R.
Isgrig, B. C., Jr.	Yerington, A. P.

Twelve active members and one applicant have become life members during 1948. They are:

Bohart, George E.	King, K. M.
Cory, Ernest N.	Peairs, L. M.
Cutright, C. R.	Poos, F. W.
Drake, Carl J	Rude, C. S.
Haviland, Elizabeth E.	Scott, Roger
Hungerford, H. B.	Weems, Howard V., Jr.
Jaynes, H. A.	

Forty-seven applications are awaiting action by the Committee.

Two active members, Dr. L. O. Howard and Dr. Herbert Osborn, have been duly proposed for honorary membership in the Association. The Committee by a majority vote recommends to the Association that Dr. Howard and Dr. Osborn be elected to honorary membership.

The Committee further reports that the Association has lost 44 active members from its roll during 1948. Of these, 30 resigned and death removed 14. Those removed by death include:

Baker, Norval	Harman, S. W.
Barber, George W.	Hopkins, A. D.
Brannon, L. W.	Metcalf, C. L.
Cockerell, T. D. A.	Sanford, H. L.
Collins, C. W.	Thompson, Robert W.
Fenton, Alfred	Watson, Lloyd R.
Glasgow, Hugh	Wilson, C. C.

This leaves the Membership of the Association at the beginning of 1949 at 2004.

L. L. ENGLISH
J. C. GAINES
R. L. METCALF
G. E. LEHKER
W. B. WOOD
HARVEY L. SWEETMAN, *Chairman*

REPORT OF THE RESOLUTIONS COMMITTEE

The Committee on Resolutions submits the following report:

1. WHEREAS: The members of the American Association of Economic Entomologists, in attendance at the 60th Annual Meeting of this Association held at New York City, N. Y. on December 13 to 16, 1948, have enjoyed a most pleasant and profitable assemblage,

Therefore, Be It Resolved: That we hereby express our cordial appreciation to the following individuals and agencies who made this occasion possible.

a. Chairman Charles L. Smith, G. G. Becker, H. C. Curran, Harry Haynes and R. S. Filmer, members of the local arrangement committee, for their untiring efforts and capable work in handling the numerous organizational details so essential to the smooth and efficient conduct of our many sessions.

b. Chairman Charles L. Palm, E. F. Knipling, and Floyd Andre of the Program Committee for arranging an outstandingly informative and stimulating program.

c. Our President and Secretary for a demonstration of unusual proficiency in the conduct of the meeting.

d. The Administrative and operational personnel of the Hotel New Yorker for their many courtesies.

e. The officers and members of the Entomological Society of America for their whole hearted cooperation in making this joint meeting a success.

2. WHEREAS: Two honored and beloved charter members of our Association, Dr. L. O. Howard and Dr. Herbert Osborn, still maintain personal interest in our organization, but were unable to attend this meeting,

Therefore, Be It Resolved: That our Secretary be instructed to forward to them our sincere greetings and best wishes.

3. WHEREAS: Fourteen of our worthy members, Norval Baker, L. W. Brannon, T. D. A. Cockerell, C. W. Collins, Alfred Fenton, Hugh Glasgow, S. W. Harman, C. L. Metcalf, H. L. Sanford, Robert W. Thompson, Lloyd R. Watson, C. C. Wilson, A. D. Hopkins and George W. Barber were called to their eternal reward during the past year,

Therefore, Be It Resolved: That we put in our permanent records this expression of our regret at the death of these our friends and fellow workers.

4. WHEREAS: The Executive Committee has (with ratification by the members) abolished several standing committees and whereas this action may lead to confusion on a matter of policy,

Therefore, Be It Resolved: That it is the consensus of this body that this action should in no way deter the President of this Association from exercising his constitutional right to appoint special temporary committees to investigate the same or similar problems as the need arises.

5. WHEREAS: The presence of impurities, variations in formulation and other factors may frequently alter the insecticidal and other properties of compounds, concentrates, or finished insecticides and thereby detract from the reliability of the experimental data obtained,

Therefore, Be It Resolved: That in order to avoid unnecessary confusion, the entomologists presenting research results should, insofar as possible, include all available information on source of materials, purity of ingredients, physical properties and formulation.

6. WHEREAS: The members of this Association have cooperated with other agencies in fostering and promoting the adoption of short, coined names to be used in place of cumbersome, chemical names for certain compounds used as insecticides, and

WHEREAS: These compounds may be or may be-

come available in various forms such as pure and variable technical grades some of which may have chemical, physical and other proeprties distinctly different from those of the grade defined or considered when the name was adopted,

Therefore, Be It Resolved: That this Association go on record as disapproving the unethical use of such names for materials not meeting the standards prescribed or implied in the definitions.

7. WHEREAS: Air transportation has greatly reduced time and distance as a factor of considerable importance in retarding the spread of insect pests, and

WHEREAS: The agencies of the government of the United States, including the Bureau of Entomology and Plant Quarantine, are participating in the facilitation of air travel and air transportation of plants and plant products, consistent with adequate protection from pest hazards, and

WHEREAS: This Association is concerned with the spread of economic insect pests through world commerce,

Therefore, Be It Resolved: That this Association endorses the establishment of a policy of suitable precautionary inspection at or near as possible to the point of origin.

8. WHEREAS: This association has previously recorded anxiety regarding limited research on the toxicity of insecticides to higher forms of animal life, and

WHEREAS: Entomologists and others are dealing with some materials that are very toxic to higher forms of animal life, and

WHEREAS: Statements and recommendations made by entomologists regarding the use of such toxic materials have a bearing on the safety and health of the public,

Therefore, Be It Resolved: That this meeting reiterate its concern with this phase of entomological research and urge provision for increased toxicological research and the early release and dissemination of data as it becomes available, and

Be It Further Resolved: That greater attention be given to the inclusion of precautionary statements in recommendations regarding the storage, handling and use of highly poisonous insecticides.

9. *Be It Further Resolved:* That copies of these resolutions be forwarded to the governmental and other agencies concerned.

J. L. HORSFALL W. V. KING
W. N. KEENAN J. N. RONEY
G. C. DECKER, *Chairman*

REPORT OF THE NOMINATING COMMITTEE

The Nominating Committee wishes to announce again the result of the letter ballot by which Dr. A. M. Boyce was elected President and Dr. C. P. Clausen was elected First Vice President.

The Nominating Committee submits the following list of nominations for your consideration:

Vice Presidents
Pacific Slope Branch, JAMES N. RONEY
Cotton States Branch, JOHN T. CREIGHTON
Eastern Branch, F. C. NELSON
North Central States Branch, F. N. WALLACE
Section of Apiculture, EVERETT OERTEL
Section of Extension, W. A. RUFFIN
Section of Plant Pest Control and Quarantine, ROBERT P. COLMER
Section of Teaching, WILLIAM P. HAYES
Section on Insecticides, LELAND B. NORTON
Section on Medical Entomology, ROBERT MATHESON
Executive Committee, CHARLES E. PALM
Committee on Membership, EPHRIAM HIXSON (1951), W. W. STANLEY (1951)
Committee on Common Names, T. A. BRINDLEY (1951), T. L. AAMODT (1951)
Editorial Board (No Changes)
Publications Committee, STANLEY E. FLANDERS *Chairman* (1951), HARLOW B. MILLS (1951)
Program Committee, H. G. JOHNSTON (1951), E. F. KNIPLING, *Chairman*
Committee on Insecticide Terminology, C. O. EDDY (1953), H. L. HALLER, *Chairman* (1952)
Trustees for Permanent Fund, CLAY LYLE (1951), H. F. DIETZ (1949), to fill unexpired term of HUGH GLASGOW (deceased)
Councillors for the AAAS, M. A. STEWART (1950)
Representative to the National Research Council, FLOYD F. SMITH (from June, 1949)

Nominating Committee
A. J. FLEBUT HARLOW B. MILLS
ARTHUR GIBSON E. R. SASSCER
J. C. CONKLIN, *Chairman*

REPORT OF THE MEETING OF THE SECTION OF PLANT PEST CONTROL AND QUARANTINE

The meeting of the Section of Plant Pest Control and Quarantine, of the American Association of Economic Entomologists, was held at the Hotel New Yorker, New York on Monday afternoon, December 13, 1948. The meeting was called to order at 1:30 by Chairman C. R. Willey.

After several announcements a nominating committee consisting of Mr. E. L. Chambers and Mr. W. B. Wood was appointed.

The following program was then presented:

1. Fruitfly Problems in Hawaii, F. G. Holdaway, St. Paul, Minn.

2. Plant Protection and Inspection Activities in Belgium and the Netherlands, E. Kostal, Hoboken, N. J.

3. Plant Inspection Activities in Canada, Nationally and Internationally, W. N. Keenan, Ottawa Canada

4. Experiences with Plan Certifications, Olaf Ryberg, Malmo Sweden

5. Progress in the Control of Migratory Locusts in Latin America, Edson J. Hambleton, Washington, D. C

6. Local Cooperative Organizations to Supervise the Control of Field Crop Pests in California, Ray F. Smith, Berkeley, Calif.

7. Effectiveness of DDT Soil and Foliage Treatments in Reducing White Fringed Beetle Larval Injury, C. F. Henderson, L. G. Hard and E. R. Millet, Gulfport, Mississippi

8. Methyl Bromide Fumigation of Orchid Plants Imported into the United States. Henry H. Richardson, Washington, D. C.

A general discussion of the topics presented ensued after the completion of the program. There was a hearty participation of those present.

The nominating Committee submitted the following names for office for 1949: R. P. Colmer, State College, Miss., Chairman, H. S. Dean, Washington, D. C., Secretary. The nominations were accepted and the nominees elected.

H. S. DEAN, *Secretary*

REPORT OF THE SECTION ON INSECTICIDES

As a result of an extended discussion at the business meeting of the Section on Insecticides, the following motion was unanimously approved:

"The Section on Insecticides petition the Association to approve the inclusion of invitational papers as a part of the annual program of this Section." Approved at the final business meeting.

At the business meeting of the Section on Insecticides, the Nominations Committee made the following recommendations in selecting officers for this Section in 1949.

L. B. Norton, Chairman
Donald Starr, Secretary

They were unanimously approved.

T. C. ALLEN, *Secretary*

REPORT OF INTERIM COMMITTEE ON MEDICAL ENTOMOLOGY,* AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The Committee on Medical Entomology was appointed by President Rohwer on July 8, 1948 with the following functions:

1. To define the purposes and functions of a Standing Committee on Medical Entomology, should they conclude that such a committee is desirable;

2. To bring to the attention of the Executive Committee recommendations they may care to make, and

3. To prepare a report on matters pertaining to the field of medical entomology which may be brought to the attention of the Association.

In carrying out these functions members of the Committee have utilized both verbal discussions and written communications, and most members have reviewed with the Interim Officers of the Section on Medical Entomology the objectives of this Section. Certain other individuals have provided helpful suggestions and Dr. Cornelius B. Philip has very kindly made available information which he has obtained in a survey on the curent status of medical entomology in leading colleges and universities. The last section of the report, which is a review of the current status of medical entomology in this country, is submitted as an appendix since it is too lengthy to be read with the regular report.

It is recommended that a Standing Committee on Medical Entomology be appointed and that this Committee include each year representatives of the Army, Navy, Public Health Service, Bureau of Entomology and Plant Quarantine, a college or university and possibly others. The principal functions of the committee should be to promote the objectives of the Section on Medical Entomology. The objectives which have been suggested by the Interim Committee correspond so closely to those set forth by the Interim Officers of the Section that they are not repeated here. One difference, however, which should be pointed out is that the Interim Committee makes a specific recommendation "to provide a medium by which the results of research in medical entomology may be made available to other interested professions." It is requested that consideration be given to the addition of this function to the listed objectives of the Section

Since the first objective of the Section defines medical entomology as "the science dealing with insects and other arthropods in their relation to the health and comfort of man and animals," it is assumed that medical entomology will be taken to include veterinary entomology.

Th potential relationship between the Standing Committee on Medical Entomology and the Section on Medical Entomology may require some clarification. The use of such a committee with its limited number of members should increase substantially the work of the Section as a broader group. The relationship may be compared with that in the American Public Health Association where a standing committee which has a major portion of its interests associated with a particular section also affords a medium for the coordination of the work of that section with other groups having related interests. This is made possible by the appointment to the committee of members from various organizations who have specialized interests in appropriate fields of medical entomology.

The Interim Committee on Medical Entomology makes the following additional recommendations:

1. In carrying out the objectives of the Section on Medical Entomology it is recommended that meetings be held in conjunction with the annual meetings of the parent association at such periods as do not conflict with the scheduled meetings of the Association as a whole.

2. It is recommended that a discussion period be included in the forthcoming session of the Section for the purpose of establishing an approved educational curriculum in the field of medical entomology.

3. The recommendation made by the former committee to the effect that papers on medical entomology be assembled under an appropriate heading in each issue of the JOURNAL has been investigated and has been found to be impractical. However, assurance has been given by the Executive Committee of the Association that every effort will be made to assemble all titles pertaining to the subject in one section of the index.

4. It is recommended that the Section on Medical Entomology give favorable attention to the former committee's suggestions that a current bibliography of papers on medical entomology worthy of note appearing in other Journals be published regularly in the JOURNAL.

* H. H. Stage; Major F. W. Whittemore, Jr.; Commander J. D. De Coursey; Professor M. A. Stewart; A. D. Hess, Chairman.

REPORT OF THE MEETING OF THE SECTION OF MEDICAL ENTOMOLOGY

The Section of Medical Entomology met at 1:30 P.M. on December 13, 1948, in the North Ballroom of the Hotel New Yorker, New York, N. Y. with S. W. Simmons, Chairman, presiding. An invitation paper entitled "Disease Vector Eradication" was presented by Dr. Fred D. Soper, Director, Pan American Sanitary Bureau. The following program of papers was presented:

1. Fumigating Properties of Several Chlorinated Hydrocarbon Insecticides Against Houseflies. R. A. Hoffman and A. W. Lindquist, Corvallis, Oregon. (Authors not present; paper not read.)

2. Experiments on Control of Black Fly Larvae in Alaskan Streams by Aerial Application of DDT. C. M. Gjullin, D. A. Sleeper, and C. N. Husman, Orlando, Fla. (Authors not present; paper read by B. V. Travis.)

3. Control of the Arctic Black Fly in the Saskatchewan River by DDT Applied from Aircraft. A. W. A. Brown, A. P. Arnason, F. J. H. Frieden, W. W. Hopewell and J. G. Rempel, London, Canada.

4. Large Scale Black Fly Control by Helicopter-Generated DDT Oil Fogs. R. D. Glasgow and D. L. Collins, Albany, N. Y.

5. Control of Alaskan Mosquito Adults by Aerial Sprays. F. S. Blanton, Major, U. S. Army, Surgeon General's Office; C. N. Husman, B. V. Travis, Orlando, Florida; C. S. Wilson, U. S. Army, Office of the Engineer, Alaska.

6. Studies of Mosquito and Other Biting Insect Problems in Alaska. B. V. Travis, Orlando, Florida.

7. Residual Toxicity of 41 Analogs of DDT to Houseflies and Mosquitoes Aedes Aegypti. R. L. Peffly and J. B. Gahan.

8. Failure of DDT to Control Houseflies. W. V. King, Orlando, Florida.

9. Observations on Housefly Control in Southern California in 1948. R. B. March and R. L. Metcalf.

At the conclusion of the program a business session was held. The following statement of objectives and procedures was adopted unanimously and later approved by the Executive Committee of the AAEE:

STATEMENT OF OBJECTIVES AND PROCEDURES, SECTION OF MEDICAL ENTOMOLOGY, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

In accordance with Article 2, Section 2, of the Constitution of the American Association of Economic Entomologists a petition was presented at the Fifty-Ninth Annual Meeting of the Association for the formation of A Section on Medical Entomology (JOUR. ECON. ENT. 41: 138, 1948). In accordance with this action, the President of the Association appointed the undersigned as officers, and a statement of objectives and procedure is hereby submitted for the approval of the Executive Committee.

OBJECTIVES:

1. To promote within the scope of the constitution and by-laws of the Association the advancement of knowledge and practice of medical entomology, which is the science dealing with insects and other arthropods in their relation to the health and comfort of man and animals.

2. To discuss medical entomology activities in relation to the related fields of medicine, veterinary medicine, engineering and other sciences.

3. To encourage a greater degree of cooperation between research institutions, governmental agencies and commercial interests in this field.

4. To encourage the highest possible standards of training.

5. To foster the advancement of medical entomology and related sciences in organizations actively engaged in this field by recommending improvement of professional status and practices, and by aiding in the procurement of professional personnel of high qualifications.

6. To provide for liaison and cooperation with medical entomology in other countries through participation in the programs of the section by entomologists of other countries.

7. To hold meetings, with or without fixed programs for the purpose of reporting upon scientific research and interchange of scientific information.

PROCEDURE:

In carrying out the above objectives, meetings of the section shall be held in connection with the annual meetings of the parent association, and at such periods as do not conflict with scheduled meetings of the Association as a whole.

The chairman appointed the following committee to nominate a slate of not less than two individuals each for chairman and secretary of the Section in 1949. It was requested that each candidate nominated be a member of the AAEE and that a report be made at the conclusion of the evening session. The following were appointed: E. F. Knipling, Chairman; G. H. Bradley; and M. A. Stewart.

It was announced that the Executive Committee AAEE had voted to discontinue the "Committee on the Development of Medical Entomology in the Association" appointed in 1947. The following committee was appointed by the chairman to work with the chairman and secretary during 1949 to advance the objectives adopted for the Section: A. D. Hess, Chairman, F. S. Blanton and W. E. Dove. The Chairman of the Section and the Secretary will serve as members of the committee.

The Monday evening session, December 13, 1948, was called to order by the Chairman at 7:30 P.M. in Parlors F and G. An invitation paper was presented entitled "The Entomologist and the International Health Program" by Dr. L. L. Williams, Jr., Medical Director, U. S. Public Health Service, Washington, D. C. The following program was presented following the address by Dr. Williams:

1. Entomology as a Career in the United States Army. Colonel O. F. Goriup, Surgeon General's Office, Washington, D. C. (Paper presented by Major Whittemore.)

2. Distribution of Domestic Rat Fleas, Murine Typhus and Rat Plague in the United States. Carl O. Mohr, Atlanta, Georgia. (Author absent, paper not read.)

3. Studies on the Sylvatic Plague Transmission Potential of Diamanus Montanus. M. A. Stewart, Berkeley, Calif.

4. Ohio's First Mosquito Control District, Herbert A. Crandell, Toledo, Ohio. (Author absent, paper not read.)

5. Control of Scabies on Man and Domestic Animals with Benzene Hexachloride. James G. Sanders, New York, N. Y.

6. Steps in the Development of Tick Control Recommendations on Long Island. D. L. Collins, R. V. Nardy and R. D. Glasgow, Albany, N. Y.

7. Practical Control of the Tick Vector of Rocky Mountain Spotted Fever on Long Island. R. D. Glasgow, D. L. Collins and R. V. Nardy, Albany, N. Y.

8. A technique for Screening Candidate Acaricides with Results Obtained. C. M. Tarzwell, H. P. Nicholson and D. P. Cullens, Savannah, Ga.

Following the presentation of papers, two motion pictures were shown entitled the following: Fogging with the Bell Aircraft Helicopter for Black Fly Control, and Studies of the Tick Vector of Rocky Mountain Spotted Fever on Long Island.

A business session was convened following the motion pictures. The Nominating Committee reported and a vote was taken for the 1949 officers of the Section. Dr. Robert Matheson was elected chairman and W. D. Reed, Secretary.

Meeting adjourned 11:5 P.M.

W. D. REED, *Secretary*

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AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
JOURNAL OF ECONOMIC ENTOMOLOGY

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JOURNAL OF ECONOMIC ENTOMOLOGY

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